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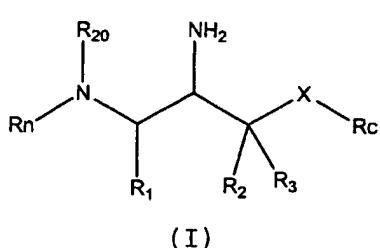
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(54) Title: SUBSTITUTED AMINOETHERS FOR THE TREATMENT OF ALZHEIMER'S DISEASE



(57) Abstract: The invention provides compounds of formula (I): useful in treating Alzheimer's disease and other similar diseases. These compounds include inhibitors of the beta-secretase enzyme that are useful in the treatment of Alzheimer's disease and other diseases characterized by deposition of A beta peptide in a mammal. The compounds of the invention are useful in pharmaceutical compositions and methods of treatment to reduce A beta peptide formation.

**SUBSTITUTED AMINOETHERS FOR THE TREATMENT
OF ALZHEIMER'S DISEASE**

CROSS REFERENCE TO RELATED APPLICATIONS

5 This application claims priority from U.S. Provisional Application Serial No. 60/409,565, filed September 10, 2002, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

10 The invention relates to substituted aminoethers and to such compounds that are useful in treatment of Alzheimer's disease and similar diseases, more specifically it relates to such compounds that inhibit β -secretase, an enzyme that cleaves amyloid precursor protein to produce A β peptide, a
15 major component of the amyloid plaques found in the brains of Alzheimer's sufferers.

Description of the Related Art

Alzheimer's disease (AD) is a progressive degenerative disease of the brain primarily associated with aging.
20 Clinical presentation of AD is characterized by loss of memory, cognition, reasoning, judgement, and orientation. As the disease progresses, motor, sensory, and linguistic abilities are also affected until there is global impairment of multiple cognitive functions. These cognitive losses occur
25 gradually, but typically lead to severe impairment and eventual death in the range of four to twelve years.

Alzheimer's disease is characterized by two major pathologic observations in the brain: neurofibrillary tangles and beta amyloid (or neuritic) plaques, comprised
30 predominantly of an aggregate of a peptide fragment known as A beta. Individuals with AD exhibit characteristic beta-amyloid deposits in the brain (beta amyloid plaques) and in cerebral blood vessels (beta amyloid angiopathy) as well as neurofibrillary tangles. Neurofibrillary tangles occur not

only in Alzheimer's disease but also in other dementia-inducing disorders. On autopsy, large numbers of these lesions are generally found in areas of the human brain important for memory and cognition.

5 Smaller numbers of these lesions in a more restricted anatomical distribution are found in the brains of most aged humans who do not have clinical AD. Amyloidogenic plaques and vascular amyloid angiopathy also characterize the brains of individuals with Trisomy 21 (Down's Syndrome), Hereditary
10 Cerebral Hemorrhage with Amyloidosis of the Dutch-Type (HCHWA-D), and other neurodegenerative disorders. Beta-amyloid is a defining feature of AD, now believed to be a causative precursor or factor in the development of disease. Deposition of A beta in areas of the brain responsible for cognitive
15 activities is a major factor in the development of AD. Beta-amyloid plaques are predominantly composed of amyloid beta peptide (A beta, also sometimes designated betaA4). A beta peptide is derived by proteolysis of the amyloid precursor protein (APP) and is comprised of 39-42 amino acids. Several
20 proteases called secretases are involved in the processing of APP.

Cleavage of APP at the N-terminus of the A beta peptide by beta-secretase and at the C-terminus by one or more gamma-secretases constitutes the beta-
25 amyloidogenic pathway, i.e. the pathway by which A beta is formed. Cleavage of APP by alpha-secretase produces alpha-sAPP, a secreted form of APP that does not result in beta-amyloid plaque formation. This alternate pathway precludes the formation of A beta peptide. A description of the proteolytic
30 processing fragments of APP is found, for example, in U.S. Patent Nos. 5,441,870; 5,721,130; and 5,942,400.

An aspartyl protease has been identified as the enzyme responsible for processing of APP at the beta-secretase cleavage site. The beta-secretase enzyme has been disclosed

using varied nomenclature, including BACE, Asp, am Mamepsin. See, for example, Sindha et.al., 1999, *Nature* 402:537-554 (p501) and published PCT application WO00/17369.

Several lines of evidence indicate that progressive 5 cerebral deposition of beta-amyloid peptide (A beta) plays a seminal role in the pathogenesis of AD and can precede cognitive symptoms by years or decades. See, for example, Selkoe, 1991, *Neuron* 6:487. Release of A beta from neuronal cells grown in culture and the presence of A beta in 10 cerebrospinal fluid (CSF) of both normal individuals and AD patients has been demonstrated. See, for example, Seubert et al., 1992, *Nature* 359:325-327.

It has been proposed that A beta peptide accumulates as a result of APP processing by beta-secretase, thus inhibition of 15 this enzyme's activity is desirable for the treatment of AD. *In vivo* processing of APP at the beta-secretase cleavage site is thought to be a rate-limiting step in A beta production, and is thus a therapeutic target for the treatment of AD. See for example, Sabbagh, M., et al., 1997, *Alz. Dis. Rev.* 3, 1- 20 19.

BACE1 knockout mice fail to produce A beta, and present a normal phenotype. When crossed with transgenic mice that overexpress APP, the progeny show reduced amounts of A beta in brain extracts as compared with control animals (Luo et.al., 25 2001 *Nature Neuroscience* 4:231-232). This evidence further supports the proposal that inhibition of beta-secretase activity and reduction of A beta in the brain provides a therapeutic method for the treatment of AD and other beta amyloid disorders.

30 Published PCT application WO00/47618 entitled "Beta-Secretase Enzyme Compositions and Methods" identifies the beta-secretase enzyme and methods of its use. This publication also discloses oligopeptide inhibitors that bind the enzyme's active site and are useful in affinity column

purification of the enzyme. In addition, WO00/77030 discloses tetrapeptide inhibitors of beta-secretase activity that are based on a statine molecule

Various pharmaceutical agents have been proposed for the 5 treatment of Alzheimer's disease but without any real success. US Patent 5,175,281 discloses 21-aminosteroids as being useful for treating Alzheimer's disease. US Patent 5,502,187 discloses bicyclic heterocyclic amines as being useful for treating Alzheimer's disease.

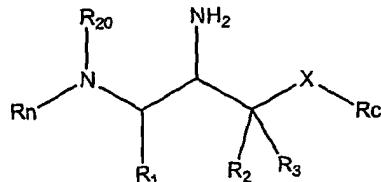
10 The hydroxyethylamine "nucleus" or isostere, of which the compounds of the invention is a truncated analog, has been used with success in the area of HIV protease inhibition. Many of these hydroxyethylamine compounds are known as well as how to make them. See for example, *J. Am. Chem. Soc.*, 93, 15 288-291 (1993), *Tetrahedron Letters*, 28(45) 5569-5572 (1987), *J. Med. Chem.*, 38(4), 581-584 (1994), *Tetrahedron Letters*, 38(4), 619-620 (1997). European Patents, numbers 702 004, 678 503, 678 514, 678 503 and 716077 by Maibaum, et al. are directed to similar isosteric strategies directed at renin 20 inhibition. See also, U.S. Pat. Nos. 5,606,078 and 5,559,111, both to Goschke, et. al.; 5,719,141, to Rasetti, et. al.; and 5,641,778, to Maibaum, et. al.

At present there are no effective treatments for halting, preventing, or reversing the progression of Alzheimer's 25 disease. Therefore, there is an urgent need for pharmaceutical agents capable of slowing the progression of Alzheimer's disease and/or preventing it in the first place.

Compounds that are effective inhibitors of beta-secretase, that inhibit beta-secretase-mediated cleavage of 30 APP, that are effective inhibitors of A beta production, and/or are effective to reduce amyloid beta deposits or plaques, are needed for the treatment and prevention of disease characterized by amyloid beta deposits or plaques, such as AD.

SUMMARY OF THE INVENTION

In a broad aspect, the invention provides compounds of formula (I):



5

(I)

or pharmaceutically acceptable salts or esters thereof;

wherein X is O, S, NR₂₀, or NR₂₀NR₂₀;

wherein each R₂₀ is H, C₁₋₆ alkyl or alkenyl, C₁₋₆ haloalkyl or

10 C₄₋₇ cycloalkyl;

wherein R₁ is -(CH₂)₁₋₂-S(O)₀₋₂-(C_{1-C₆} alkyl), or

C_{1-C₁₀} alkyl optionally substituted with 1, 2, or 3 groups

independently selected from halogen, -OH, =O, -SH,

-C≡N, -CF₃, -C_{1-C₃} alkoxy, amino, mono- or

15 dialkylamino, -N(R)C(O)R'-, -OC(=O)-amino and -OC(=O)-mono- or dialkylamino, or

C_{2-C₆} alkenyl or C_{2-C₆} alkynyl, each of which is optionally

substituted with 1, 2, or 3 groups independently

selected from halogen, -OH, -SH, -C≡N, -CF₃, C_{1-C₃}

20 alkoxy, amino, and mono- or dialkylamino, or

aryl, heteroaryl, heterocyclyl, -C_{1-C₆} alkyl-aryl, -C_{1-C₆}

alkyl-heteroaryl, or -C_{1-C₆} alkyl-heterocyclyl, where

the ring portions of each are optionally substituted

with 1, 2, 3, or 4 groups independently selected

25 from halogen, -OH, -SH, -C≡N, -NR₁₀₅R'₁₀₅, -CO₂R, -

N(R)COR', or -N(R)SO₂R', -C(=O)-(C_{1-C₄}) alkyl, -SO₂-

amino, -SO₂-mono or dialkylamino, -C(=O)-amino,

-C(=O)-mono or dialkylamino, -SO₂-(C_{1-C₄}) alkyl, or

C_{1-C₆} alkoxy optionally substituted with 1, 2, or 3

30 groups which are independently selected from halogen, or

C₃-C₇ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, -C₁-C₆ alkyl and mono- or dialkylamino, or
 5 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, -C₁-C₃ alkoxy, amino, mono- or dialkylamino and -C₁-C₃ alkyl, or
 10 C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl each of which is optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, C₁-C₆ alkyl and mono- or dialkylamino; and the heterocyclyl group is optionally further substituted with
 15 oxo;

R and R' independently are hydrogen, C₁-C₁₀ alkyl, C₁-C₁₀ alkylaryl or C₁-C₁₀ alkylheteroaryl; wherein R_c is hydrogen, -(CR₂₄₅R₂₅₀)₀₋₄-aryl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl, -(CR₂₄₅R₂₅₀)₀₋₄-aryl-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-aryl-aryl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl-aryl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl-heterocyclyl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl-heterocyclyl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl-aryl, -[C(R₂₅₅)(R₂₆₀)]₁₋₃-CO-N-(R₂₅₅)₂, -CH(aryl)₂, -CH(heteroaryl)₂, -CH(heterocyclyl)₂, -CH(aryl)(heteroaryl), -(CH₂)₀₋₁-CH((CH₂)₀₋₆-OH)-(CH₂)₀₋₁-aryl, -(CH₂)₀₋₁-CH((CH₂)₀₋₆-OH)-(CH₂)₀₋₁-heteroaryl, -CH(-aryl or -heteroaryl)-CO-O(C₁-C₄ alkyl), -CH(-CH₂-OH)-CH(OH)-phenyl-NO₂, (C₁-C₆ alkyl)-O-(C₁-C₆ alkyl)-OH; -CH₂-NH-CH₂-CH(-O-CH₂-CH₃)₂, -(CH₂)₀₋₆-C(=NR₂₃₅)(NR₂₃₅R₂₄₀), or
 25 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of

R₂₀₅, -OC=ONR₂₃₅R₂₄₀, -S(=O)₀₋₂(C₁-C₆ alkyl), -SH,
 -NR₂₃₅C=ONR₂₃₅R₂₄₀, -C=ONR₂₃₅R₂₄₀, and -S(=O)₂NR₂₃₅R₂₄₀, or
 - (CH₂)₀₋₃-(C₃-C₈) cycloalkyl wherein the cycloalkyl is
 5 optionally substituted with 1, 2, or 3 groups
 independently selected from the group consisting of
 R₂₀₅, -CO₂H, and -CO₂-(C₁-C₄ alkyl), or
 cyclopentyl, cyclohexyl, or cycloheptyl ring fused to
 aryl, heteroaryl, or heterocyclyl wherein one, two
 or three carbons of the cyclopentyl, cyclohexyl, or
 10 cycloheptyl is optionally replaced with a heteroatom
 independently selected from NH, NR₂₁₅, O, or S(=O)₀₋₂,
 and wherein the cyclopentyl, cyclohexyl, or
 cycloheptyl group can be optionally substituted with
 one or two groups that are independently R₂₀₅, =O,
 15 -CO-NR₂₃₅R₂₄₀, or -SO₂-(C₁-C₄ alkyl), or
 C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl, each of which is
 optionally substituted with 1, 2, or 3 R₂₀₅ groups,
 wherein
 each aryl and heteroaryl is optionally substituted with
 20 1, 2, or 3 R₂₀₀, and wherein each heterocyclyl is
 optionally substituted with 1, 2, 3, or 4 R₂₁₀;
 R₂₀₀ at each occurrence is independently selected from -OH,
 -NO₂, halogen, -CO₂H, C≡N, -(CH₂)₀₋₄-CO-NR₂₂₀R₂₂₅, -(CH₂)₀₋₄-
 CO-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-CO-(C₂-C₁₂ alkenyl), -(CH₂)₀₋₄-
 25 CO-(C₂-C₁₂ alkynyl), -(CH₂)₀₋₄-CO-(C₃-C₇ cycloalkyl), -(CH₂)₀₋₄-CO-aryl,
 -(CH₂)₀₋₄-CO-heteroaryl, -(CH₂)₀₋₄-CO-heterocyclyl, -(CH₂)₀₋₄-CO-O-R₂₁₅,
 -(CH₂)₀₋₄-SO₂-NR₂₂₀R₂₂₅, -(CH₂)₀₋₄-SO-(C₁-C₈ alkyl),
 30 -(CH₂)₀₋₄-SO₂-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-SO₂-(C₃-C₇ cycloalkyl), -(CH₂)₀₋₄-N(H or R₂₁₅)-CO-O-R₂₁₅,
 -(CH₂)₀₋₄-N(H or R₂₁₅)-CO-N(R₂₁₅)₂, -(CH₂)₀₋₄-N-CS-N(R₂₁₅)₂,
 -(CH₂)₀₋₄-N(-H or R₂₁₅)-CO-R₂₂₀, -(CH₂)₀₋₄-NR₂₂₀R₂₂₅,
 -(CH₂)₀₋₄-O-CO-(C₁-C₆ alkyl), -(CH₂)₀₋₄-O-P(O)-(OR₂₄₀)₂,
 -(CH₂)₀₋₄-O-CO-N(R₂₁₅)₂, -(CH₂)₀₋₄-O-CS-N(R₂₁₅)₂, -(CH₂)₀₋₄-O-
 (R₂₁₅), -(CH₂)₀₋₄-O-(R₂₁₅)-COOH, -(CH₂)₀₋₄-S-(R₂₁₅), -(CH₂)₀₋₄-
 (R₂₁₅)

O-(C₁-C₆ alkyl optionally substituted with 1, 2, 3, or 5 -F), C₃-C₇ cycloalkyl, -(CH₂)₀₋₄-N(H or R₂₁₅)-SO₂-R₂₂₀, -(CH₂)₀₋₄-C₃-C₇ cycloalkyl, or

10 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 R₂₀₅ groups, or

5 C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl, each of which is optionally substituted with 1 or 2 R₂₀₅ groups, wherein

15 the aryl and heteroaryl groups at each occurrence are optionally substituted with 1, 2, or 3 groups that are independently R₂₀₅, R₂₁₀, or

20 C₁-C₆ alkyl substituted with 1, 2, or 3 groups that are independently R₂₀₅ or R₂₁₀, and wherein

the heterocyclyl group at each occurrence is optionally substituted with 1, 2, or 3 groups that are independently R₂₁₀;

25 R₂₀₅ at each occurrence is independently selected from C₁-C₆ alkyl, halogen, -OH, -O-phenyl, -SH, -C≡N, -CF₃, C₁-C₆ alkoxy, NH₂, NH(C₁-C₆ alkyl) or N-(C₁-C₆ alkyl)(C₁-C₆ alkyl);

30 R₂₁₀ at each occurrence is independently selected from halogen, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, -NR₂₂₀R₂₂₅, OH, C≡N, -CO-(C₁-C₄ alkyl), -SO₂-NR₂₃₅R₂₄₀, -CO-NR₂₃₅R₂₄₀, -SO₂-(C₁-C₄ alkyl), =O, or

25 C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl or C₃-C₇ cycloalkyl, each of which is optionally substituted with 1, 2, or 3 R₂₀₅ groups;

35 R₂₁₅ at each occurrence is independently selected from C₁-C₆ alkyl, -(CH₂)₀₋₂-(aryl), C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₇ cycloalkyl, and -(CH₂)₀₋₂-(heteroaryl), -(CH₂)₀₋₂-(heterocyclyl), wherein

the aryl group at each occurrence is optionally substituted with 1, 2, or 3 groups that are independently R₂₀₅ or R₂₁₀, and wherein

the heterocyclyl and heteroaryl groups at each occurrence are optionally substituted with 1, 2, or 3 R_{210} ;

5 R_{220} and R_{225} at each occurrence are independently selected from -H, -C₃-C₇ cycloalkyl, -(C₁-C₂ alkyl)-(C₃-C₇ cycloalkyl), -(C₁-C₆ alkyl)-O-(C₁-C₃ alkyl), -C₂-C₆ alkenyl, -C₂-C₆ alkynyl, -C₁-C₆ alkyl chain with one double bond and one triple bond, -aryl, -heteroaryl, and -heterocyclyl, or -C₁-C₁₀ alkyl optionally substituted with -OH, -NH₂ or halogen, wherein

10 the aryl, heterocyclyl and heteroaryl groups at each occurrence are optionally substituted with 1, 2, or 3 R_{270} groups

R_{235} and R_{240} at each occurrence are independently H, or C₁-C₆ alkyl;

15 R_{245} and R_{250} at each occurrence are independently selected from -H, C₁-C₄ alkyl, C₁-C₄ alkylaryl, C₁-C₄ alkylheteroaryl, C₁-C₄ hydroxyalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, -(CH₂)₀₋₄-C₃-C₇ cycloalkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, and phenyl; or

20 R_{245} and R_{250} are taken together with the carbon to which they are attached to form a carbocycle of 3, 4, 5, 6, or 7 carbon atoms, where one carbon atom is optionally replaced by a heteroatom selected from -O-, -S-, -SO₂-, and -NR₂₂₀-;

25 R_{255} and R_{260} at each occurrence are independently selected from -H, -(CH₂)₁₋₂-S(O)₀₋₂-(C₁-C₆ alkyl), -(C₁-C₄ alkyl)-aryl, -(C₁-C₄ alkyl)-heteroaryl, -(C₁-C₄ alkyl)-heterocyclyl, -aryl, -heteroaryl, -heterocyclyl, -(CH₂)₁₋₄-R₂₆₅-(CH₂)₀₋₄-aryl, -(CH₂)₁₋₄-R₂₆₅-(CH₂)₀₋₄-heteroaryl, -(CH₂)₁₋₄-R₂₆₅-(CH₂)₀₋₄-heterocyclyl, or

30 C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl or -(CH₂)₀₋₄-C₃-C₇ cycloalkyl, each of which is optionally substituted with 1, 2, or 3 R_{205} groups, wherein

each aryl or phenyl is optionally substituted with 1, 2, or 3 groups that are independently R_{205} , R_{210} , or $C_1\text{-}C_6$ alkyl substituted with 1, 2, or 3 groups that are independently R_{205} or R_{210} , and wherein

5 each heterocyclyl is optionally substituted with 1, 2, 3, or 4 R_{210} ;

R_{265} at each occurrence is independently -O- , -S- or $\text{-N(C}_1\text{-C}_6\text{ alkyl)-}$;

10 R_{270} at each occurrence is independently R_{205} , halogen $C_1\text{-}C_6$ alkoxy, $C_1\text{-}C_6$ haloalkoxy, $\text{NR}_{235}R_{240}$, -OH , $\text{-C}\equiv\text{N}$, $\text{-CO-}(C_1\text{-}C_4\text{ alkyl})$, $\text{-SO}_2\text{NR}_{235}R_{240}$, $\text{-CO-NR}_{235}R_{240}$, $\text{-SO}_2\text{-}(C_1\text{-}C_4\text{ alkyl})$, $=\text{O}$, or

15 $C_1\text{-}C_6$ alkyl, $C_2\text{-}C_6$ alkenyl, $C_2\text{-}C_6$ alkynyl or $\text{-(CH}_2\text{)}_{0\text{-}4}\text{-C}_3\text{-C}_7$ cycloalkyl, each of which is optionally substituted with 1, 2, or 3 R_{205} groups;

20 R_n is R'_{100} , $\text{-SO}_2R'_{100}$, $\text{-(CRR')}_{1\text{-}6}R'_{100}$, $\text{-C(=O)-}(CRR')_{0\text{-}6}R_{100}$, $\text{-C(=O)-}(CRR')_{1\text{-}6}\text{-O-R'}_{100}$, $\text{-C(=O)-}(CRR')_{1\text{-}6}\text{-S-R'}_{100}$, $\text{-C(=O)-}(CRR')_{1\text{-}6}\text{-C(=O)-R}_{100}$, $\text{-C(=O)-}(CRR')_{1\text{-}6}\text{-SO}_2\text{-R}_{100}$; or $\text{Y-Z-X'}\text{-(CH}_2\text{)}_{n7}\text{-CHC(O)-R}_4$;

25 R_4 is selected from the group consisting of H ; NH_2 ; $\text{-NH-}(CH_2)_{n6-}R_{4-1}$; -NHR_8 ; $\text{-NR}_{50}\text{C(O)R}_5$; $C_1\text{-}C_4$ alkyl- NHC(O)R_5 ; $\text{-(CH}_2\text{)}_{0\text{-}4}R_8$; $\text{-O-C}_1\text{-}C_4$ alkanoyl; OH ; $C_6\text{-C}_{10}$ aryloxy optionally substituted with 1, 2, or 3 groups that are independently halogen, $C_1\text{-}C_4$ alkyl, $\text{-CO}_2\text{H}$, $\text{-C(O)-C}_1\text{-}C_4$ alkoxy, or $C_1\text{-}C_4$ alkoxy; $C_1\text{-}C_6$ alkoxy; aryl $C_1\text{-}C_4$ alkoxy; $\text{-NR}_{50}\text{CO}_2\text{R}_{51}$; $\text{-C}_1\text{-}C_4$ alkyl- $\text{NR}_{50}\text{CO}_2\text{R}_{51}$; $\text{-C}\equiv\text{N}$; -CF_3 ; $\text{-CF}_2\text{-CF}_3$; $\text{-C}\equiv\text{CH}$; $\text{-CH}_2\text{-CH=CH}_2$; $\text{-(CH}_2\text{)}_{1\text{-}4}\text{-R}_{4-1}$; $\text{-(CH}_2\text{)}_{1\text{-}4}\text{-NH-R}_{4-1}$; $\text{-O-}(CH_2)_{n6-}R_{4-1}$; $\text{-S-}(CH_2)_{n6-}R_{4-1}$; $\text{-(CH}_2\text{)}_{0\text{-}4}\text{-NHC(O)-}(CH_2)_{0\text{-}6}\text{-R}_{52}$; $\text{-(CH}_2\text{)}_{0\text{-}4}\text{-R}_{53}\text{-}(CH_2)_{0\text{-}4}\text{-R}_{54}$;

30 wherein

n_6 is 0, 1, 2, or 3;

n_7 is 0, 1, 2, or 3;

R_{4-1} is selected from the group consisting of $\text{-SO}_2\text{-}(C_1\text{-}C_8\text{ alkyl})$, $\text{-SO-}(C_1\text{-}C_8\text{ alkyl})$, $\text{-S-}(C_1\text{-}C_8\text{ alkyl})$, -S-CO-

(C₁-C₆ alkyl), -SO₂-NR₄₋₂R₄₋₃; -CO-C₁-C₂ alkyl; -CO-NR₄₋₃R₄₋₄;

R₄₋₂ and R₄₋₃ are independently H, C₁-C₃ alkyl, or C₃-C₆ cycloalkyl;

5 R₄₋₄ is alkyl, arylalkyl, alkanoyl, or arylalkanoyl;

R₄₋₆ is H or C₁-C₆ alkyl;

R₅ is selected from the group consisting of C₃-C₇ cycloalkyl; C₁-C₆ alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen,

10 -NR₆R₇, C₁-C₄ alkoxy, C₅-C₆ heterocycloalkyl, C₅-C₆ heteroaryl, C₆-C₁₀ aryl, C₃-C₇ cycloalkyl C₁-C₄ alkyl, -S-C₁-C₄ alkyl, -SO₂-C₁-C₄ alkyl, -CO₂H, -CONR₆R₇, -CO₂-C₁-C₄ alkyl, C₆-C₁₀ aryloxy; heteroaryl optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, C₁-C₄ haloalkyl, or OH; heterocycloalkyl optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, or C₂-C₄ alkanoyl; aryl optionally substituted with 1, 2, 3, or 4 groups that are independently halogen, OH, C₁-C₄ alkyl, C₁-C₄ alkoxy, or C₁-C₄ haloalkyl; and -NR₆R₇; wherein

15 R₆ and R₇ are independently selected from the group consisting of H, C₁-C₆ alkyl, C₂-C₆ alkanoyl, phenyl, -SO₂-C₁-C₄ alkyl, phenyl C₁-C₄ alkyl;

20 R₈ is selected from the group consisting of -SO₂-heteroaryl, -SO₂-aryl, -SO₂-heterocycloalkyl, -SO₂-C₁-C₁₀ alkyl, -C(O)NHR₉, heterocycloalkyl, -S-C₁-C₆ alkyl, -S-C₂-C₄ alkanoyl, wherein

25 R₉ is aryl C₁-C₄ alkyl, C₁-C₆ alkyl, or H;

30 R₅₀ is H or C₁-C₆ alkyl;

R₅₁ is selected from the group consisting of aryl C₁-C₄ alkyl; C₁-C₆ alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen, cyano,

heteroaryl, $-\text{NR}_6\text{R}_7$, $-\text{C}(\text{O})\text{NR}_6\text{R}_7$, $\text{C}_3\text{-C}_7$ cycloalkyl, or
 $-\text{C}_1\text{-C}_4$ alkoxy; heterocycloalkyl optionally
 substituted with 1 or 2 groups that are
 independently $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_4$ alkoxy, halogen, $\text{C}_2\text{-}$
 5 C_4 alkanoyl, aryl $\text{C}_1\text{-C}_4$ alkyl, and $-\text{SO}_2\text{C}_1\text{-C}_4$ alkyl;
 alkenyl; alkynyl; heteroaryl optionally substituted
 with 1, 2, or 3 groups that are independently OH , $\text{C}_1\text{-}$
 10 C_4 alkyl, $\text{C}_1\text{-C}_4$ alkoxy, halogen, NH_2 , $\text{NH}(\text{C}_1\text{-C}_6$ alkyl)
 or $\text{N}(\text{C}_1\text{-C}_6$ alkyl) $(\text{C}_1\text{-C}_6$ alkyl); heteroarylalkyl
 15 optionally substituted with 1, 2, or 3 groups that
 are independently $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_4$ alkoxy, halogen,
 NH_2 , $\text{NH}(\text{C}_1\text{-C}_6$ alkyl) or $\text{N}(\text{C}_1\text{-C}_6$ alkyl) $(\text{C}_1\text{-C}_6$ alkyl);
 aryl; heterocycloalkyl; $\text{C}_3\text{-C}_8$ cycloalkyl; and
 cycloalkylalkyl; wherein the aryl; heterocycloalkyl,
 20 $\text{C}_3\text{-C}_8$ cycloalkyl, and cycloalkylalkyl groups are
 optionally substituted with 1, 2, 3, 4 or 5 groups
 that are independently halogen, CN , NO_2 , $\text{C}_1\text{-C}_6$ alkyl,
 $\text{C}_1\text{-C}_6$ alkoxy, $\text{C}_2\text{-C}_6$ alkanoyl, $\text{C}_1\text{-C}_6$ haloalkyl, $\text{C}_1\text{-C}_6$
 25 haloalkoxy, hydroxy, $\text{C}_1\text{-C}_6$ hydroxyalkyl, $\text{C}_1\text{-C}_6$ alkoxy
 $\text{C}_1\text{-C}_6$ alkyl, $\text{C}_1\text{-C}_6$ thioalkoxy, $\text{C}_1\text{-C}_6$ thioalkoxy $\text{C}_1\text{-C}_6$
 alkyl, or $\text{C}_1\text{-C}_6$ alkoxy $\text{C}_1\text{-C}_6$ alkoxy;
 30 R_{52} is heterocycloalkyl, heteroaryl, aryl, cycloalkyl,
 $-\text{S}(\text{O})_{0-2}\text{-C}_1\text{-C}_6$ alkyl, CO_2H , $-\text{C}(\text{O})\text{NH}_2$, $-\text{C}(\text{O})\text{NH}(\text{alkyl})$,
 $-\text{C}(\text{O})\text{N}(\text{alkyl})(\text{alkyl})$, $-\text{CO}_2\text{-alkyl}$, $-\text{NHS}(\text{O})_{0-2}\text{-C}_1\text{-C}_6$
 35 alkyl, $-\text{N}(\text{alkyl})\text{S}(\text{O})_{0-2}\text{-C}_1\text{-C}_6$ alkyl, $-\text{S}(\text{O})_{0-2}\text{-}$
 heteroaryl, $-\text{S}(\text{O})_{0-2}\text{-aryl}$, $-\text{NH}(\text{arylalkyl})$,
 $-\text{N}(\text{alkyl})(\text{arylalkyl})$, thioalkoxy, or alkoxy, each of
 40 which is optionally substituted with 1, 2, 3, 4, or
 5 groups that are independently alkyl, alkoxy,
 thioalkoxy, halogen, haloalkyl, haloalkoxy,
 alkanoyl, NO_2 , CN , alkoxycarbonyl, or aminocarbonyl;
 45 R_{53} is absent, $-\text{O}-$, $-\text{C}(\text{O})-$, $-\text{NH}-$, $-\text{N}(\text{alkyl})-$, $-\text{NH-S}(\text{O})_{0-2}-$,
 $-\text{N}(\text{alkyl})\text{-S}(\text{O})_{0-2}-$, $-\text{S}(\text{O})_{0-2}\text{-NH-}$, $-\text{S}(\text{O})_{0-2}\text{-N}(\text{alkyl})-$,
 $-\text{NH-C}(\text{S})-$, or $-\text{N}(\text{alkyl})\text{-C}(\text{S})-$;
 50

R₅₄ is heteroaryl, aryl, arylalkyl, heterocycloalkyl, CO₂H, -CO₂-alkyl, -C(O)NH(alkyl), -C(O)N(alkyl) (alkyl), -C(O)NH₂, C₁-C₈ alkyl, OH, aryloxy, alkoxy, arylalkoxy, NH₂, NH(alkyl), N(alkyl) (alkyl), or -C₁-C₆ alkyl-CO₂-C₁-C₆ alkyl, each of which is optionally substituted with 1, 2, 3, 4, or 5 groups that are independently alkyl, alkoxy, CO₂H, -CO₂-alkyl, thioalkoxy, halogen, haloalkyl, haloalkoxy, hydroxyalkyl, alkanoyl, NO₂, CN, alkoxycarbonyl, or aminocarbonyl;

X' is selected from the group consisting of -C₁-C₆ alkylidenyl optionally optionally substituted with 1, 2, or 3 methyl groups; and -NR₄₋₆-; or

R₄ and R₄₋₆ combine to form -(CH₂)_{n10}-, wherein

n₁₀ is 1, 2, 3, or 4;

Z is selected from the group consisting of a bond; SO₂; SO; S; and C(O);

Y is selected from the group consisting of H; C₁-C₄ haloalkyl; C₅-C₆ heterocycloalkyl; C₆-C₁₀ aryl; OH; -N(Y₁)(Y₂); C₁-C₁₀ alkyl optionally substituted with 1 thru 3 substituents which can be the same or different and are selected from the group consisting of halogen, hydroxy, alkoxy, thioalkoxy, and haloalkoxy; C₃-C₈ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₃ alkyl, and halogen; alkoxy; aryl optionally substituted with halogen, alkyl, alkoxy, CN or NO₂; arylalkyl optionally substituted with halogen, alkyl, alkoxy, CN or NO₂; wherein

Y₁ and Y₂ are the same or different and are H; C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 substituents selected from the group consisting of halogen, C₁-C₄ alkoxy, C₃-C₈ cycloalkyl, and OH; C₂-C₆ alkenyl; C₂-C₆ alkanoyl; phenyl; -SO₂-C₁-C₄ alkyl; phenyl C₁-C₄ alkyl; or C₃-C₈ cycloalkyl C₁-C₄ alkyl; or

Y_1 , Y_2 and the nitrogen to which they are attached form a ring selected from the group consisting of piperazinyl, piperidinyl, morpholinyl, and pyrrolidinyl, wherein each ring is optionally substituted with 1, 2, 3, or 4 groups that are independently C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_1 - C_6 alkoxy C_1 - C_6 alkyl, or halogen;

5 R_{100} and R'_{100} independently represent aryl, heteroaryl, -aryl-W-aryl, -aryl-W-heteroaryl, -aryl-W-heterocyclyl, -heteroaryl-W-aryl, -heteroaryl-W-heteroaryl, -heteroaryl-W-heterocyclyl, -heterocyclyl-W-aryl, -heterocyclyl-W-heterocyclyl, -heterocyclyl-W-heteroaryl, where the ring portions of each are optionally 10 substituted with 1, 2, or 3 groups independently selected from

15 -OR, -NO₂, halogen, -C≡N, -OCF₃, -CF₃, -(CH₂)₀₋₄O-P(=O)(OR)(OR'), -(CH₂)₀₋₄-CO-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄O-(CH₂)₀₋₄-CONR₁₀₂R₁₀₂', -(CH₂)₀₋₄-CO-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-CO-(C₂-C₁₂ alkenyl), -(CH₂)₀₋₄-CO-(C₂-C₁₂ alkynyl), 20 -(CH₂)₀₋₄-CO-(CH₂)₀₋₄(C₃-C₇ cycloalkyl), -(CH₂)₀₋₄-R₁₁₀, -(CH₂)₀₋₄-R₁₂₀, -(CH₂)₀₋₄-R₁₃₀, -(CH₂)₀₋₄-CO-R₁₁₀, -(CH₂)₀₋₄-CO-R₁₂₀, -(CH₂)₀₋₄-CO-R₁₃₀, -(CH₂)₀₋₄-CO-R₁₄₀, -(CH₂)₀₋₄-CO-O-R₁₅₀, -(CH₂)₀₋₄-SO₂-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-SO-(C₁-C₈ 25 alkyl), -(CH₂)₀₋₄-SO₂-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-SO₂-(CH₂)₀₋₄-(C₃-C₇ cycloalkyl), -(CH₂)₀₋₄-N(R₁₅₀)-CO-O-R₁₅₀, -(CH₂)₀₋₄-N(R₁₅₀)-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-N(R₁₅₀)-CS-N(R₁₅₀)₂, -(CH₂)₀₋₄-N(R₁₅₀)-CO-R₁₀₅, -(CH₂)₀₋₄-NR₁₀₅R'₁₀₅, 30 -(CH₂)₀₋₄-R₁₄₀, -(CH₂)₀₋₄-O-CO-(C₁-C₆ alkyl), -(CH₂)₀₋₄-O-P(O)-(O-R₁₁₀)₂, -(CH₂)₀₋₄-O-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-O-CS-N(R₁₅₀)₂, -(CH₂)₀₋₄-O-(R₁₅₀), -(CH₂)₀₋₄-O-R₁₅₀'-COOH, -(CH₂)₀₋₄-S-(R₁₅₀), -(CH₂)₀₋₄-N(R₁₅₀)-SO₂-R₁₀₅, -(CH₂)₀₋₄-C₃-C₇ cycloalkyl, (C₂-C₁₀) alkenyl, or (C₂-C₁₀) alkynyl, or

R_{100} is C_1 - C_{10} alkyl optionally substituted with 1, 2, or 3 R_{115} groups, or

R_{100} is $-(C_1$ - C_6 alkyl)- O - C_1 - C_6 alkyl) or $-(C_1$ - C_6 alkyl)- S -(C_1 - C_6 alkyl), each of which is optionally substituted with 1, 2, or 3 R_{115} groups, or

5 R_{100} is C_3 - C_8 cycloalkyl optionally substituted with 1, 2, or 3 R_{115} groups;

W is $-(CH_2)_{0-4}-$, $-O-$, $-S(O)_{0-2}-$, $-N(R_{135})-$, $-CR(OH)-$ or $-C(O)-$;

R_{102} and R_{102}' independently are hydrogen, or

10 C_1 - C_{10} alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen, aryl or $-R_{110}$;

R_{105} and R'_{105} independently represent $-H$, $-R_{110}$, $-R_{120}$, C_3 - C_7 cycloalkyl, $-(C_1$ - C_2 alkyl)- $(C_3$ - C_7 cycloalkyl), $-(C_1$ - C_6 alkyl)- O - $(C_1$ - C_3 alkyl), C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, or C_1 - C_6 alkyl chain with one double bond and one triple bond,

15 or

C_1 - C_6 alkyl optionally substituted with $-OH$ or $-NH_2$; or,

C_1 - C_6 alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, or

20 R_{105} and R'_{105} together with the atom to which they are attached form a 3 to 7 membered carbocyclic ring, where one member is optionally a heteratom selected from $-O-$, $-S(O)_{0-2}-$, $-N(R_{135})-$, the ring being optionally substituted with 1, 2 or three R_{140} groups;

25 R_{115} at each occurrence is independently halogen, $-OH$, $-CO_2R_{102}$, $-C_1$ - C_6 thioalkoxy, $-CO_2$ -phenyl, $-NR_{105}R'_{135}$, $-SO_2$ -(C_1 - C_8 alkyl), $-C(=O)R_{180}$, R_{180} , $-CONR_{105}R'_{105}$, $-SO_2NR_{105}R'_{105}$, $-NH-CO-(C_1$ - C_6 alkyl), $-NH-C(=O)-OH$, $-NH-C(=O)-OR$, $-NH-C(=O)-O$ -phenyl, $-O-C(=O)-(C_1$ - C_6 alkyl), $-O-C(=O)$ -amino, $-O-C(=O)-$ mono- or dialkylamino, $-O-C(=O)$ -phenyl, $-O-(C_1$ - C_6 alkyl)- CO_2H , $-NH-SO_2$ -(C_1 - C_6 alkyl), C_1 - C_6 alkoxy or C_1 - C_6 haloalkoxy;

30

R₁₃₅ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₇ cycloalkyl, -(CH₂)₀₋₂₋(aryl), -(CH₂)₀₋₂₋(heteroaryl), or -(CH₂)₀₋₂₋(heterocyclyl);

R₁₄₀ is heterocyclyl optionally substituted with 1, 2, 3, or 4 groups independently selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, halogen, hydroxy, cyano, nitro, amino, mono(C₁-C₆)alkylamino, di(C₁-C₆)alkylamino, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₁-C₆ haloalkoxy, amino(C₁-C₆)alkyl, mono(C₁-C₆)alkylamino(C₁-C₆)alkyl, di(C₁-C₆)alkylamino(C₁-C₆)alkyl, and =O;

R₁₅₀ is hydrogen, C₃-C₇ cycloalkyl, -(C₁-C₂ alkyl)-(C₃-C₇ cycloalkyl), C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ alkyl with one double bond and one triple bond, -R₁₁₀, -R₁₂₀, or C₁-C₆ alkyl optionally substituted with 1, 2, 3, or 4 groups independently selected from -OH, -NH₂, C₁-C₃ alkoxy, R₁₁₀, and halogen;

R_{150'} is C₃-C₇ cycloalkyl, -(C₁-C₃ alkyl)-(C₃-C₇ cycloalkyl), C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ alkyl with one double bond and one triple bond, -R₁₁₀, -R₁₂₀, or C₁-C₆ alkyl optionally substituted with 1, 2, 3, or 4 groups independently selected from -OH, -NH₂, C₁-C₃ alkoxy, R₁₁₀, and halogen;

R₁₈₀ is selected from morpholinyl, thiomorpholinyl, piperazinyl, piperidinyl, homomorpholinyl, homothiomorpholinyl, homothiomorpholinyl S-oxide, homothiomorpholinyl S,S-dioxide, pyrrolinyl and pyrrolidinyl, each of which is optionally substituted with 1, 2, 3, or 4 groups independently selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, halogen, hydroxy, cyano, nitro, amino, mono(C₁-C₆)alkylamino, di(C₁-C₆)alkylamino, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₁-C₆ haloalkoxy, amino(C₁-C₆)alkyl, mono(C₁-C₆)alkylamino(C₁-C₆)alkyl, di(C₁-C₆)alkylamino(C₁-C₆)alkyl, and =O;

R₁₁₀ is aryl optionally substituted with 1 or 2 R₁₂₅ groups;

R_{125} at each occurrence is independently halogen, amino, mono- or dialkylamino, -OH, -C≡N, -SO₂-NH₂, -SO₂-NH-C₁-C₆ alkyl, -SO₂-N(C₁-C₆ alkyl)₂, -SO₂-(C₁-C₄ alkyl), -CO-NH₂, -CO-NH-C₁-C₆ alkyl, or -CO-N(C₁-C₆ alkyl)₂, or

5 C₁-C₆ alkyl, C₂-C₆ alkenyl or C₂-C₆ alkynyl, each of which is optionally substituted with 1, 2, or 3 groups that are independently selected from C₁-C₃ alkyl, halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, and mono- and dialkylamino, or

10 C₁-C₆ alkoxy optionally substituted with one, two or three of halogen;

R_{120} is heteroaryl, which is optionally substituted with 1 or 2 R_{125} groups; and

15 R_{130} is heterocyclyl optionally substituted with 1 or 2 R_{125} groups; and

20 R_2 is selected from the group consisting of H; C₁-C₆ alkyl, optionally substituted with 1, 2, or 3 substituents that are independently selected from the group consisting of C₁-C₃ alkyl, halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, and -NR_{1-a}R_{1-b}; wherein

R_{1-a} and R_{1-b} are -H or C₁-C₆ alkyl;
-(CH₂)₀₋₄-aryl; -(CH₂)₀₋₄-heteroaryl; C₂-C₆ alkenyl; C₂-C₆ alkynyl; -CONR_{N-2}R_{N-3}; -SO₂NR_{N-2}R_{N-3}; -CO₂H; and -CO₂-(C₁-C₄ alkyl);

25 R_3 is selected from the group consisting of H; C₁-C₆ alkyl, optionally substituted with 1, 2, or 3 substituents independently selected from the group consisting of C₁-C₃ alkyl, halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, and -NR_{1-a}R_{1-b}; -(CH₂)₀₋₄-aryl; -(CH₂)₀₋₄-heteroaryl; C₂-C₆ alkenyl; C₂-C₆ alkynyl; -CO-NR_{N-2}R_{N-3}; -SO₂-NR_{N-2}R_{N-3}; -CO₂H; and -CO-O-(C₁-C₄ alkyl);

30 wherein

R_{N-2} and R_{N-3} at each occurrence are independently selected from the group consisting of

-C₁-C₈ alkyl optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of -OH, -NH₂, phenyl and halogen; -C₃-C₈ cycloalkyl; -(C₁-C₂ alkyl)-(C₃-C₈ cycloalkyl); -(C₁-C₆ alkyl)-O-(C₁-C₃ alkyl); -C₂-C₆ alkenyl; -C₂-C₆ alkynyl; -C₁-C₆ alkyl chain with one double bond and one triple bond; aryl; heteroaryl; heterocycloalkyl; or

R_{N-2}, R_{N-3} and the nitrogen to which they are attached form a 5, 6, or 7 membered heterocycloalkyl or heteroaryl group, wherein said heterocycloalkyl or heteroaryl group is optionally fused to a benzene, pyridine, or pyrimidine ring, and said groups are unsubstituted or substituted with 1, 2, 3, 4, or 5 groups that at each occurrence are independently C₁-C₆ alkyl, C₁-C₆ alkoxy, halogen, halo C₁-C₆ alkyl, halo C₁-C₆ alkoxy, -CN, -NO₂, -NH₂, NH(C₁-C₆ alkyl), N(C₁-C₆ alkyl)(C₁-C₆ alkyl), -OH, -C(O)NH₂, -C(O)NH(C₁-C₆ alkyl), -C(O)N(C₁-C₆ alkyl)(C₁-C₆ alkyl), C₁-C₆ alkoxy C₁-C₆ alkyl, C₁-C₆ thioalkoxy, and C₁-C₆ thioalkoxy C₁-C₆ alkyl;

or wherein,

R₂, R₃ and the carbon to which they are attached form a carbocycle of three thru seven carbon atoms, wherein one carbon atom is optionally replaced by a group selected from-O-, -S-, -SO₂-, or -NR_{N-2}-.

The invention also provides a method for making a compound of formula (I)

or a pharmaceutically acceptable salt or ester thereof.

The invention also includes a method of treating a patient who has, or is preventing a patient from getting, a disease or condition selected from the group consisting of Alzheimer's disease, for helping prevent or delay the onset of Alzheimer's disease, for treating patients with mild cognitive

impairment (MCI) and preventing or delaying the onset of Alzheimer's disease in those who would progress from MCI to AD, for treating Down's syndrome, for treating humans who have Hereditary Cerebral Hemorrhage with Amyloidosis of the Dutch-
5 Type, for treating cerebral amyloid angiopathy and preventing its potential consequences, i.e. single and recurrent lobar hemorrhages, for treating other degenerative dementias, including dementias of mixed vascular and degenerative origin, dementia associated with Parkinson's disease, dementia
10 associated with progressive supranuclear palsy, dementia associated with cortical basal degeneration, or diffuse Lewy body type of Alzheimer's disease and who is in need of such treatment which comprises administration of a therapeutically effective amount of a compound of formula (I).

15 The invention also includes methods for inhibiting beta-secretase activity, for inhibiting cleavage of amyloid precursor protein (APP), in a reaction mixture, at a site between Met596 and Asp597, numbered for the APP-695 amino acid isotype; or at a corresponding site of an isotype or mutant
20 thereof, for inhibiting production of amyloid beta peptide (A beta) in a cell, for inhibiting the production of beta-amyloid plaque in an animal, and for treating or preventing a disease characterized by beta-amyloid deposits in the brain which comprise administration of a therapeutically effective amount
25 of a compound of formula (I).

The invention also includes a pharmaceutical composition that comprises a compound of formula (I), or pharmaceutically acceptable salts and esters thereof, and one or more pharmaceutically acceptable inert carriers.

30 The invention also includes the use of compounds of formula (I), or pharmaceutically acceptable salts and esters thereof, for the manufacture of a medicament for use in treating a patient who has, or in preventing a patient from getting, a disease or condition selected from the group

consisting of Alzheimer's disease, for helping prevent or delay the onset of Alzheimer's disease, for treating patients with mild cognitive impairment (MCI) and preventing or delaying the onset of Alzheimer's disease in those who would 5 progress from MCI to AD, for treating Down's syndrome, for treating humans who have Hereditary Cerebral Hemorrhage with Amyloidosis of the Dutch-Type, for treating cerebral amyloid angiopathy and preventing its potential consequences, i.e. single and recurrent lobar hemorrhages, for treating other 10 degenerative dementias, including dementias of mixed vascular and degenerative origin, dementia associated with Parkinson's disease, dementia associated with progressive supranuclear palsy, dementia associated with cortical basal degeneration, diffuse Lewy body type of Alzheimer's disease and who is in 15 need of such treatment.

The invention provides compounds, compositions, kits, and methods for inhibiting beta-secretase-mediated cleavage of amyloid precursor protein (APP). More particularly, the 20 compounds, compositions, and methods of the invention are effective to inhibit the production of A beta peptide and to treat or prevent any human or veterinary disease or condition associated with a pathological form of A beta peptide.

The compounds, compositions, and methods of the invention are useful for treating humans who have Alzheimer's Disease 25 (AD), for helping prevent or delay the onset of AD, for treating patients with mild cognitive impairment (MCI), and preventing or delaying the onset of AD in those patients who would otherwise be expected to progress from MCI to AD, for treating Down's syndrome, for treating Hereditary Cerebral 30 Hemorrhage with Amyloidosis of the Dutch Type, for treating cerebral beta-amyloid angiopathy and preventing its potential consequences such as single and recurrent lobar hemorrhages, for treating other degenerative dementias, including dementias of mixed vascular and degenerative origin, for treating

dementia associated with Parkinson's disease, dementia associated with progressive supranuclear palsy, dementia associated with cortical basal degeneration, and diffuse Lewy body type AD.

5 The invention also provides intermediates and methods useful for preparing the compounds of Formula I, or pharmaceutically acceptable salts or esters thereof.

10 The compounds of the invention possess beta-secretase inhibitory activity. The inhibitory activities of the compounds of the invention are readily demonstrated, for example, using one or more of the assays described herein or known in the art.

15 Unless the substituents for a particular formula are expressly defined for that formula, they are understood to carry the definitions set forth in connection with the preceding formula to which the particular formula makes reference.

DETAILED DESCRIPTION OF THE INVENTION

20 Preferred compounds of formula I include compounds of formula I-1, i.e., compounds of formula I wherein Rn is $-C(=O)-(CRR')_{1-6}R_{100}$, and wherein R, R' and R₁₀₀ are as defined above.

25 Preferred compounds of formula I-1 include compounds wherein Rn is $-C(=O)-(CRR')_{0-6}R_{100}$, where R and R' are as defined above and where R₁₀₀ is as defined above, but is not heterocyclyl-W-aryl.

Preferred compounds of formula I-1 also include those wherein Rn is $-C(=O)-R_{100}$; and

30 R₁₀₀ represents aryl, or heteroaryl, where the ring portions of each are optionally substituted with 1, 2, or 3 groups independently selected from

-OR, -NO₂, C₁-C₆ alkyl, halogen, -C≡N, -OCF₃, -CF₃, -(CH₂)₀₋₄-O-P(=O)(OR)(OR'), -(CH₂)₀₋₄-CO-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-O-(CH₂)₀₋₄-CONR₁₀₂R'₁₀₂, -(CH₂)₀₋₄-CO-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-

4-CO-(C₂-C₁₂ alkenyl), -(CH₂)₀₋₄-CO-(C₂-C₁₂ alkynyl),
 -(CH₂)₀₋₄-CO-(CH₂)₀₋₄(C₃-C₇ cycloalkyl), -(CH₂)₀₋₄-R₁₁₀,
 -(CH₂)₀₋₄-R₁₂₀, -(CH₂)₀₋₄-R₁₃₀, -(CH₂)₀₋₄-CO-R₁₁₀, -(CH₂)₀₋₄-
 CO-R₁₂₀, -(CH₂)₀₋₄-CO-R₁₃₀, -(CH₂)₀₋₄-CO-R₁₄₀, -(CH₂)₀₋₄-
 5 CO-O-R₁₅₀, -(CH₂)₀₋₄-SO₂-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-SO-(C₁-C₈
 alkyl), -(CH₂)₀₋₄-SO₂-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-SO₂-
 (CH₂)₀₋₄-(C₃-C₇ cycloalkyl), -(CH₂)₀₋₄-N(R₁₅₀)-CO-O-R₁₅₀,
 -(CH₂)₀₋₄-N(R₁₅₀)-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-N(R₁₅₀)-CS-
 10 N(R₁₅₀)₂, -(CH₂)₀₋₄-N(R₁₅₀)-CO-R₁₀₅, -(CH₂)₀₋₄-NR₁₀₅R'₁₀₅,
 -(CH₂)₀₋₄-R₁₄₀, -(CH₂)₀₋₄-O-CO-(C₁-C₆ alkyl), -(CH₂)₀₋₄-O-
 P(O)-(O-R₁₁₀)₂, -(CH₂)₀₋₄-O-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-O-CS-
 N(R₁₅₀)₂, -(CH₂)₀₋₄-O-(R₁₅₀), -(CH₂)₀₋₄-O-R₁₅₀'-COOH, -
 (CH₂)₀₋₄-S-(R₁₅₀), -(CH₂)₀₋₄-N(R₁₅₀)-SO₂-R₁₀₅, -(CH₂)₀₋₄-
 C₃-C₇ cycloalkyl, (C₂-C₁₀) alkenyl, or (C₂-C₁₀) alkynyl.

15 Preferred compounds of formula I-1 further include those
 wherein R_n is -C(=O)-aryl or -C(=O)-heteroaryl wherein the
 ring portions of each are optionally substituted with 1, 2, or
 3 groups independently selected from:

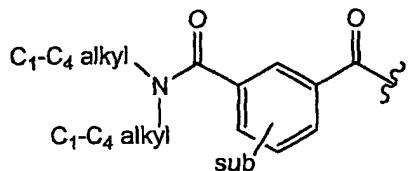
-OR, -NO₂, C₁-C₆ alkyl, halogen, -C≡N, -OCF₃, -CF₃, -(CH₂)₀₋
 20 -₄-CO-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-O-(CH₂)₀₋₄-CONR₁₀₂R₁₀₂', -(CH₂)₀₋
 4-CO-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-CO-(C₂-C₁₂ alkenyl),
 -(CH₂)₀₋₄-CO-(C₂-C₁₂ alkynyl), -(CH₂)₀₋₄-R₁₁₀, -(CH₂)₀₋₄-
 R₁₂₀, -(CH₂)₀₋₄-R₁₃₀, -(CH₂)₀₋₄-CO-R₁₁₀, -(CH₂)₀₋₄-CO-R₁₂₀,
 -(CH₂)₀₋₄-CO-R₁₃₀, -(CH₂)₀₋₄-CO-R₁₄₀, -(CH₂)₀₋₄-CO-O-R₁₅₀,
 25 -(CH₂)₀₋₄-SO₂-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-SO-(C₁-C₈ alkyl),
 -(CH₂)₀₋₄-SO₂-(C₁-C₁₂ alkyl), -(CH₂)₀₋₄-N(R₁₅₀)-CO-O-R₁₅₀,
 -(CH₂)₀₋₄-N(R₁₅₀)-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-N(R₁₅₀)-CO-R₁₀₅,
 -(CH₂)₀₋₄-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-R₁₄₀, -(CH₂)₀₋₄-O-CO-(C₁-C₆
 alkyl), -(CH₂)₀₋₄-O-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-O-(R₁₅₀), -
 30 -(CH₂)₀₋₄-N(R₁₅₀)-SO₂-R₁₀₅, -(CH₂)₀₋₄-C₃-C₇ cycloalkyl,
 (C₂-C₁₀) alkenyl, or (C₂-C₁₀) alkynyl.

Preferred compounds of formula I-1 further include those
 wherein R_n is -C(=O)-aryl or -C(=O)-heteroaryl, wherein the

ring portions of each are optionally substituted with 1 or 2 groups independently selected from:

C₁-C₆ alkyl, halogen, -(CH₂)₀₋₄-CO-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-O-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-N(R₁₅₀)-SO₂-R₁₀₅, -(CH₂)₀₋₄-SO₂-NR₁₀₅R'₁₀₅, C₃-C₇ cycloalkyl, (C₂-C₁₀) alkenyl, -(CH₂)₀₋₄-R₁₁₀, -(CH₂)₀₋₄-R₁₂₀, -(CH₂)₀₋₄-R₁₃₀, or (C₂-C₁₀) alkynyl.

Preferred compounds of formula I-1 further include those wherein R_n is:

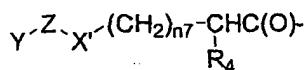


10

wherein sub is hydrogen or is C₁-C₆ alkyl, halogen, -(CH₂)₀₋₄-CO-NR₁₀₅R'₁₀₅, -(CH₂)₀₋₄-O-CO-N(R₁₅₀)₂, -(CH₂)₀₋₄-N(R₁₅₀)-SO₂-R₁₀₅, -(CH₂)₀₋₄-SO₂-NR₁₀₅R'₁₀₅, C₃-C₇ cycloalkyl, (C₂-C₁₀) alkenyl, -(CH₂)₀₋₄-R₁₁₀, -(CH₂)₀₋₄-R₁₂₀, -(CH₂)₀₋₄-R₁₃₀, or (C₂-C₁₀) alkynyl.

15

Preferred compounds of formula I also include compounds of formula I-2, i.e., compounds of formula I wherein R_n is



20

wherein

R₄ is selected from the group consisting of H; NH₂; -NH-(CH₂)_{n6}-R₄₋₁; -NHR₈; -NR₅₀C(O)R₅; C₁-C₄ alkyl-NHC(O)R₅; -(CH₂)₀₋₄R₈; -O-C₁-C₄ alkanoyl; OH; C₆-C₁₀ aryloxy optionally substituted with 1, 2, or 3 groups that are independently halogen, C₁-C₄ alkyl, -CO₂H, -C(O)-C₁-C₄ alkoxy, or C₁-C₄ alkoxy; C₁-C₆ alkoxy; aryl C₁-C₄ alkoxy; -NR₅₀CO₂R₅₁; -C₁-C₄ alkyl-NR₅₀CO₂R₅₁; -C≡N; -CF₃; -CF₂-CF₃; -C≡CH; -CH₂-CH=CH₂; -(CH₂)₁₋₄-R₄₋₁; -(CH₂)₁₋₄-NH-R₄₋₁; -O-(CH₂)_{n6}-R₄₋₁; -S-(CH₂)_{n6}-R₄₋₁; -(CH₂)₀₋₄-NHC(O)-(CH₂)₀₋₆-R₅₂; -(CH₂)₀₋₄-R₅₃-(CH₂)₀₋₄-R₅₄;

wherein

n₆ is 0, 1, 2, or 3;
n₇ is 0, 1, 2, or 3;
R₄₋₁ is selected from the group consisting of -SO₂-(C₁-C₈ alkyl), -SO-(C₁-C₈ alkyl), -S-(C₁-C₈ alkyl), -S-CO-(C₁-C₆ alkyl), -SO₂-NR₄₋₂R₄₋₃; -CO-C₁-C₂ alkyl; -CO-NR₄₋₃R₄₋₄;

5 R₄₋₂ and R₄₋₃ are independently H, C₁-C₃ alkyl, or C₃-C₆ cycloalkyl;

R₄₋₄ is alkyl, arylalkyl, alkanoyl, or arylalkanoyl;

10 R₄₋₆ is -H or C₁-C₆ alkyl;

R₅ is selected from the group consisting of C₃-C₇ cycloalkyl; C₁-C₆ alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen, -NR₆R₇, C₁-C₄ alkoxy, C₅-C₆ heterocycloalkyl, C₅-C₆ heteroaryl, C₆-C₁₀ aryl, C₃-C₇ cycloalkyl C₁-C₄ alkyl, -S-C₁-C₄ alkyl, -SO₂-C₁-C₄ alkyl, -CO₂H, -CONR₆R₇, -CO₂-C₁-C₄ alkyl, C₆-C₁₀ aryloxy; heteroaryl optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, C₁-C₄ haloalkyl, or OH; heterocycloalkyl optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, or C₂-C₄ alkanoyl; aryl optionally substituted with 1, 2, 3, or 4 groups that are independently halogen, OH, C₁-C₄ alkyl, C₁-C₄ alkoxy, or C₁-C₄ haloalkyl; and -NR₆R₇; wherein

15 R₆ and R₇ are independently selected from the group consisting of H, C₁-C₆ alkyl, C₂-C₆ alkanoyl, phenyl, -SO₂-C₁-C₄ alkyl, phenyl C₁-C₄ alkyl;

20 R₈ is selected from the group consisting of -SO₂-heteroaryl, -SO₂-aryl, -SO₂-heterocycloalkyl, -SO₂-C₁-C₁₀ alkyl, -C(O)NHR₉, heterocycloalkyl, -S-C₁-C₆ alkyl, -S-C₂-C₄ alkanoyl, wherein

25 R₉ is aryl C₁-C₄ alkyl, C₁-C₆ alkyl, or H;

R₅₀ is H or C₁-C₆ alkyl;

R₅₁ is selected from the group consisting of aryl C₁-C₄ alkyl; C₁-C₆ alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen, cyano, heteroaryl, -NR₆R₇, -C(O)NR₆R₇, C₃-C₇ cycloalkyl, or -C₁-C₄ alkoxy; heterocycloalkyl optionally substituted with 1 or 2 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, C₂-C₄ alkanoyl, aryl C₁-C₄ alkyl, and -SO₂ C₁-C₄ alkyl; alkenyl; alkynyl; heteroaryl optionally substituted with 1, 2, or 3 groups that are independently OH, C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, NH₂, NH(C₁-C₆ alkyl) or N(C₁-C₆ alkyl)(C₁-C₆ alkyl); heteroarylalkyl optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, NH₂, NH(C₁-C₆ alkyl) or N(C₁-C₆ alkyl)(C₁-C₆ alkyl); aryl; heterocycloalkyl; C₃-C₈ cycloalkyl; and cycloalkylalkyl; wherein the aryl; heterocycloalkyl, C₃-C₈ cycloalkyl, and cycloalkylalkyl groups are optionally substituted with 1, 2, 3, 4 or 5 groups that are independently halogen, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆ alkanoyl, C₁-C₆ haloalkyl, C₁-C₆ haloalkoxy, hydroxy, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy C₁-C₆ alkyl, C₁-C₆ thioalkoxy, C₁-C₆ thioalkoxy C₁-C₆ alkyl, or C₁-C₆ alkoxy C₁-C₆ alkoxy;

R₅₂ is heterocycloalkyl, heteroaryl, aryl, cycloalkyl, -S(O)₀₋₂-C₁-C₆ alkyl, CO₂H, -C(O)NH₂, -C(O)NH(alkyl), -C(O)N(alkyl)(alkyl), -CO₂-alkyl, -NHS(O)₀₋₂-C₁-C₆ alkyl, -N(alkyl)S(O)₀₋₂-C₁-C₆ alkyl, -S(O)₀₋₂-heteroaryl, -S(O)₀₋₂-aryl, -NH(arylalkyl), -N(alkyl)(arylalkyl), thioalkoxy, or alkoxy, each of which is optionally substituted with 1, 2, 3, 4, or 5 groups that are independently alkyl, alkoxy,

thioalkoxy, halogen, haloalkyl, haloalkoxy, alkanoyl, NO_2 , CN, alkoxycarbonyl, or aminocarbonyl; R₅₃ is absent, -O-, -C(O)-, -NH-, -N(alkyl)-, -NH-S(O)₀₋₂₋, -N(alkyl)-S(O)₀₋₂₋, -S(O)₀₋₂₋NH-, -S(O)₀₋₂₋N(alkyl)-, -NH-C(S)-, or -N(alkyl)-C(S)-;

5 R₅₄ is heteroaryl, aryl, arylalkyl, heterocycloalkyl, CO_2H , -CO₂-alkyl, -C(O)NH(alkyl), -C(O)N(alkyl) (alkyl), -C(O)NH₂, C₁-C₈ alkyl, OH, aryloxy, alkoxy, arylalkoxy, NH₂, NH(alkyl), N(alkyl) (alkyl), or -C₁-C₆ alkyl-CO₂-C₁-C₆ alkyl, each of which is optionally substituted with 1, 2, 3, 4, or 5 groups that are independently alkyl, alkoxy, CO_2H , -CO₂-alkyl, thioalkoxy, halogen, haloalkyl, haloalkoxy, hydroxyalkyl, alkanoyl, NO_2 , CN, alkoxycarbonyl, or aminocarbonyl;

10 X' is selected from the group consisting of -C₁-C₆ alkylidenyl optionally optionally substituted with 1, 2, or 3 methyl groups; and -NR₄₋₆-; or

15 R₄ and R₄₋₆ combine to form -(CH₂)_{n10}-, wherein R₄ and R₄₋₆ combine to form -(CH₂)_{n10}-, wherein n₁₀ is 1, 2, 3, or 4;

20 Z is selected from the group consisting of a bond; SO_2 ; SO; S; and C(O);

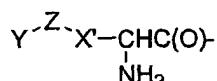
25 Y is selected from the group consisting of H; C₁-C₄ haloalkyl; C₅-C₆ heterocycloalkyl; C₆-C₁₀ aryl; OH; -N(Y₁)(Y₂); C₁-C₁₀ alkyl optionally substituted with 1 thru 3 substituents which can be the same or different and are selected from the group consisting of halogen, hydroxy, alkoxy, thioalkoxy, and haloalkoxy; C₃-C₈ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₃ alkyl, and halogen; alkoxy; aryl optionally substituted with halogen, alkyl, alkoxy, CN or NO_2 ; arylalkyl optionally substituted with halogen, alkyl, alkoxy, CN or NO_2 ; wherein

Y₁ and Y₂ are the same or different and are H; C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 substituents selected from the group consisting of halogen, C₁-C₄ alkoxy, C₃-C₈ cycloalkyl, and OH; C₂-C₆ alkenyl; C₂-C₆ alkanoyl; phenyl; -SO₂-C₁-C₄ alkyl; phenyl C₁-C₄ alkyl; or C₃-C₈ cycloalkyl C₁-C₄ alkyl; or

5 Y₁, Y₂ and the nitrogen to which they are attached form a ring selected from the group consisting of piperazinyl, piperidinyl, morpholinyl, and pyrrolidinyl, wherein each ring is optionally substituted with 1, 2, 3, or 4 groups that are independently C₁-C₆ alkyl, C₁-C₆ alkoxy, C₁-C₆ alkoxy C₁-C₆ alkyl, or halogen.

10 Preferred compounds of formula I-2 also include compounds wherein R_n is

15



wherein

X' is C₁-C₄ alkylideneyl optionally substituted with 1, 2, or 3 methyl groups; or -NR₄₋₆-, where R₄₋₆ is H or C₁-C₆ alkyl; or

20 R₄ and R₄₋₆ combine to form -(CH₂)_{n₁₀}-, where R₄ and R₄₋₆ are as defined above, wherein

n₁₀ is 1, 2, 3, or 4;

Z is selected from a bond; SO₂; SO; S; and C(O);

25 Y is selected from H; C₁-C₄ haloalkyl; C₅-C₆ heterocycloalkyl containing at least one N, O, or S; phenyl; OH; -N(Y₁)(Y₂); C₁-C₁₀ alkyl optionally substituted with 1 thru 3 substituents which can be the same or different and are selected from halogen, hydroxy, alkoxy, thioalkoxy, and

30 haloalkoxy; C₃-C₈ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₃ alkyl, and halogen; alkoxy; phenyl optionally substituted with halogen, C₁-C₄ alkyl, C₁-C₄ alkoxy, CN or NO₂; phenyl C₁-C₄ alkyl

optionally substituted with halogen, C₁-C₄ alkyl, C₁-C₄ alkoxy, CN or NO₂; wherein

Y₁ and Y₂ are the same or different and are H; C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 substituents selected
5 from the group consisting of halogen, C₁-C₄ alkoxy, C₃-C₈ cycloalkyl, and OH; C₂-C₆ alkenyl; C₂-C₆ alkanoyl; phenyl; -SO₂-C₁-C₄ alkyl; phenyl C₁-C₄ alkyl; and C₃-C₈ cycloalkyl C₁-C₄ alkyl; or

10 -N(Y₁) (Y₂) forms a ring selected from piperazinyl, piperidinyl, morpholinyl, and pyrrolidinyl, wherein each ring is optionally substituted with 1, 2, 3, or 4 groups that are independently C₁-C₆ alkyl, C₁-C₆ alkoxy, C₁-C₆ alkoxy C₁-C₆ alkyl, or halogen.

15 Preferred compounds of formula I-2 further include compounds wherein

X' is C₁-C₄ alkylidenyl optionally substituted with 1, 2, or 3 methyl groups;

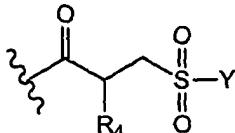
Z is selected from SO₂; SO; S; and C(O);

Y is selected from H; C₁-C₄ haloalkyl; C₅-C₆ heterocycloalkyl
20 containing at least one N, O, or S; phenyl; OH; -N(Y₁) (Y₂); C₁-C₁₀ alkyl optionally substituted with 1 thru 3 substituents which can be the same or different and are selected from the group consisting of halogen, hydroxy, alkoxy, thioalkoxy, and haloalkoxy; C₃-C₈ cycloalkyl
25 optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₃ alkyl, and halogen; alkoxy; phenyl optionally substituted with halogen, C₁-C₄ alkyl, C₁-C₄ alkoxy, CN or NO₂; phenyl C₁-C₄ alkyl optionally substituted with halogen, C₁-C₄ alkyl, C₁-C₄ alkoxy, CN or NO₂; wherein

30 Y₁ and Y₂ are the same or different and are H; C₁-C₆ alkyl optionally substituted with 1, 2, or 3 substituents selected from the group consisting of halogen, C₁-C₄ alkoxy, C₃-C₈ cycloalkyl, and OH; C₂-C₆ alkenyl; C₂-C₆

5 alkanoyl; phenyl; $-\text{SO}_2-\text{C}_1\text{-C}_4$ alkyl; phenyl $\text{C}_1\text{-C}_4$
alkyl; or $\text{C}_3\text{-C}_8$ cycloalkyl $\text{C}_1\text{-C}_4$ alkyl; or
 $-\text{N}(\text{Y}_1)(\text{Y}_2)$ forms a ring selected from piperazinyl,
piperidinyl, morpholinyl, and pyrrolidinyl, wherein
each ring is optionally substituted with 1, 2, 3, or
4 groups that are independently $\text{C}_1\text{-C}_6$ alkyl, $\text{C}_1\text{-C}_6$
alkoxy, $\text{C}_1\text{-C}_6$ alkoxy $\text{C}_1\text{-C}_6$ alkyl, or halogen.

Preferred compounds of formula I-2 include compounds wherein Rn is $\text{O}=\text{C}(\text{R})\text{C}(\text{R})=\text{O}$



10 and wherein R_4 is NH_2 ; $-NH-(CH_2)_{n6}-R_{4-1}$; $-NHR_8$; $-NR_{50}C(O)R_5$;
or $-NR_{50}CO_2R_{51}$ wherein
15 n_6 is 0, 1, 2, or 3;
 n_7 is 0, 1, 2, or 3;
 R_{4-1} is selected from the group consisting of $-SO_2-(C_1-C_8$ alkyl), $-SO-(C_1-C_8$ alkyl), $-S-(C_1-C_8$ alkyl), $-S-CO-(C_1-C_6$ alkyl), $-SO_2-NR_{4-2}R_{4-3}$; $-CO-C_1-C_2$ alkyl; $-CO-NR_{4-3}R_{4-4}$;
 R_{4-2} and R_{4-3} are independently H, C_1-C_3 alkyl, or C_3-C_6 cycloalkyl;
20 R_{4-4} is alkyl, phenylalkyl, C_2-C_4 alkanoyl, or phenylalkanoyl;
 R_5 is cyclopropyl; cyclobutyl; cyclopentyl; or cyclohexyl; wherein each cycloalkyl group is optionally substituted with one or two groups that are C_1-C_6 alkyl, more preferably C_1-C_2 alkyl, C_1-C_6 alkoxy, more preferably C_1-C_2 alkoxy, CF_3 , OH , NH_2 , $NH(C_1-C_6$ alkyl), $N(C_1-C_6$ alkyl)(C_1-C_6 alkyl), halogen, CN , or NO_2 ; or the cycloalkyl group is substituted with 1 or 2 groups that are independently CF_3 , Cl , F , methyl, ethyl or cyano; C_1-C_6 alkyl optionally substituted with 1, 2, or 3 groups that are independently

halogen, $-\text{NR}_6\text{R}_7$, $\text{C}_1\text{-C}_4$ alkoxy, $\text{C}_5\text{-C}_6$ heterocycloalkyl, $\text{C}_5\text{-C}_6$ heteroaryl, phenyl, $\text{C}_3\text{-C}_7$ cycloalkyl, $-\text{S-C}_1\text{-C}_4$ alkyl, $-\text{SO}_2\text{-C}_1\text{-C}_4$ alkyl, $-\text{CO}_2\text{H}$, $-\text{CONR}_6\text{R}_7$, $-\text{CO}_2\text{-C}_1\text{-C}_4$ alkyl, or phenoxy; heteroaryl optionally substituted with 1, 2, or 3 groups that are independently $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_4$ alkoxy, halogen, $\text{C}_1\text{-C}_4$ haloalkyl, or OH; heterocycloalkyl optionally substituted with 1, 2, or 3 groups that are independently $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_4$ alkoxy, halogen, or $\text{C}_2\text{-C}_4$ alkanoyl; phenyl optionally substituted with 1, 2, 3, or 4 groups that are independently halogen, OH, $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_4$ alkoxy, or $\text{C}_1\text{-C}_4$ haloalkyl; and $-\text{NR}_6\text{R}_7$; wherein

R_6 and R_7 are independently selected from the group consisting of H, $\text{C}_1\text{-C}_6$ alkyl, $\text{C}_2\text{-C}_6$ alkanoyl, phenyl, $-\text{SO}_2\text{-C}_1\text{-C}_4$ alkyl, and phenyl $\text{C}_1\text{-C}_4$ alkyl;

R_8 is selected from the group consisting of $-\text{SO}_2$ -heteroaryl optionally substituted with 1 or 2 groups that are independently $\text{C}_1\text{-C}_4$ alkyl or halogen; $-\text{SO}_2$ -aryl, $-\text{SO}_2$ -heterocycloalkyl, $-\text{C}(\text{O})\text{NHR}_9$, heterocycloalkyl, $-\text{S-C}_2\text{-C}_4$ alkanoyl, wherein R_9 is phenyl $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_6$ alkyl, or H;

R_{50} is H or $\text{C}_1\text{-C}_6$ alkyl; and

R_{51} is selected from the group consisting of phenyl $\text{C}_1\text{-C}_4$ alkyl; $\text{C}_1\text{-C}_6$ alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen, cyano, $-\text{NR}_6\text{R}_7$, $-\text{C}(\text{O})\text{NR}_6\text{R}_7$, $\text{C}_3\text{-C}_7$ or $-\text{C}_1\text{-C}_4$ alkoxy; heterocycloalkyl optionally substituted with 1 or 2 groups that are independently $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_4$ alkoxy, halogen, $\text{C}_2\text{-C}_4$ alkanoyl, phenyl $\text{C}_1\text{-C}_4$ alkyl, and $-\text{SO}_2\text{-C}_1\text{-C}_4$ alkyl; heterocycloalkylalkyl optionally substituted with 1 or 2 groups that are independently $\text{C}_1\text{-C}_4$ alkyl, $\text{C}_1\text{-C}_4$ alkoxy, halogen, $\text{C}_2\text{-C}_4$ alkanoyl, phenyl $\text{C}_1\text{-C}_4$ alkyl, and $-\text{SO}_2\text{-C}_1\text{-C}_4$ alkyl;

5 alkenyl; alkynyl; heteroaryl optionally substituted with 1, 2, or 3 groups that are independently OH, C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, NH₂, NH(C₁-C₆ alkyl) or N(C₁-C₆ alkyl)(C₁-C₆ alkyl); heteroarylalkyl optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, NH₂, NH(C₁-C₆ alkyl) or N(C₁-C₆ alkyl)(C₁-C₆ alkyl); phenyl; C₃-C₈ cycloalkyl, and cycloalkylalkyl, wherein the phenyl; C₃-C₈ cycloalkyl, and cycloalkylalkyl groups are optionally substituted with 1, 2, 3, 4 or 5 groups that are independently halogen, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆ alkanoyl, C₁-C₆ haloalkyl, C₁-C₆ haloalkoxy, hydroxy, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy C₁-C₆ alkyl, C₁-C₆ thioalkoxy, C₁-C₆ thioalkoxy C₁-C₆ alkyl, or C₁-C₆ alkoxy C₁-C₆ alkoxy; and

10 Y is C₁-C₁₀ alkyl optionally substituted with 1 thru 3 substituents which can be the same or different and are selected from halogen, hydroxy, alkoxy, thioalkoxy, and haloalkoxy.

15

20

Preferred compounds of formula I, formula I-1 and formula I-2 include compounds of formula I-3, i.e., compounds of formula I, I-1 or I-2 wherein:

25 R₁ is (CH₂)_{n1}-(R₁-aryl) where n₁ is zero or one and R₁-aryl is phenyl optionally substituted with 1, 2, 3, or 4 groups independently selected from C₁-C₆ alkyl optionally substituted with 1, 2, or 3 substituents selected from the group consisting of C₁-C₃ alkyl, halogen, -OH, -SH, -NR_{1-a}R_{1-b}, -C≡N, -CF₃, and C₁-C₃ alkoxy; halogen; C₁-C₆ alkoxy; -NR_{N-2}R_{N-3}; and OH; wherein
 30 R_{1-a} and R_{1-b} are -H or C₁-C₆ alkyl;
 R_{N-2} and R_{N-3} at each occurrence are independently selected from the group consisting of -C₁-C₈ alkyl optionally

selected from the group consisting of -OH, -NH₂, phenyl and halogen; -C₃-C₈ cycloalkyl; -(C₁-C₂ alkyl)- (C₃-C₈ cycloalkyl); -(C₁-C₆ alkyl)-O-(C₁-C₃ alkyl); -C₂-C₆ alkenyl; -C₂-C₆ alkynyl; -C₁-C₆ alkyl chain with one double bond and one triple bond; aryl; heteroaryl; heterocycloalkyl; or

5 R_{N-2}, R_{N-3} and the nitrogen to which they are attached form a 5, 6, or 7 membered heterocycloalkyl or heteroaryl group, wherein said heterocycloalkyl or heteroaryl group is optionally fused to a benzene, pyridine, or pyrimidine ring, and said groups are unsubstituted or substituted with 1, 10 2, 3, 4, or 5 groups that at each occurrence are independently C₁-C₆ alkyl, C₁-C₆ alkoxy, halogen, halo C₁-C₆ alkyl, halo C₁-C₆ alkoxy, 15 -CN, -NO₂, -NH₂, NH(C₁-C₆ alkyl), N(C₁-C₆ alkyl)(C₁-C₆ alkyl), -OH, -C(O)NH₂, -C(O)NH(C₁-C₆ alkyl), -C(O)N(C₁-C₆ alkyl)(C₁-C₆ alkyl), C₁-C₆ alkoxy C₁-C₆ alkyl, C₁-C₆ thioalkoxy, and C₁-C₆ 20 thioalkoxy C₁-C₆ alkyl.

Preferred compounds of formula I-3 include compounds wherein:

25 R₁ is aryl, heteroaryl, heterocyclyl, -C₁-C₆ alkyl-aryl, -C₁-C₆ alkyl-heteroaryl, or -C₁-C₆ alkyl-heterocyclyl, where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, -OH, -SH, -C≡N, -NO₂, -NR₁₀₅R'₁₀₅, -CO₂R, -N(R)COR', or -N(R)SO₂R' (where R₁₀₅, R'₁₀₅, R and R' are as defined above), -C(=O)-(C₁-C₄)alkyl, -SO₂-amino, -SO₂-mono or dialkylamino, -C(=O)-amino, -C(=O)-mono or dialkylamino, -SO₂-(C₁-C₄)alkyl, or

C_1 - C_6 alkoxy optionally substituted with 1, 2, or 3 groups which are independently selected from halogen, or

5 C_3 - C_7 cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C_1 - C_3 alkoxy, amino, - C_1 - C_6 alkyl and mono- or dialkylamino, or

10 C_1 - C_{10} alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, - C_1 - C_3 alkoxy, amino, mono- or dialkylamino and - C_1 - C_3 alkyl, or

15 C_2 - C_{10} alkenyl or C_2 - C_{10} alkynyl each of which is optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C_1 - C_3 alkoxy, amino, C_1 - C_6 alkyl and mono- or dialkylamino; and the heterocyclyl group is optionally further substituted with oxo.

Preferred compounds of formula I-3 include compounds
20 wherein:

25 R_1 is - C_1 - C_6 alkyl-aryl, - C_1 - C_6 alkyl-heteroaryl, or - C_1 - C_6 alkyl-heterocyclyl, where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, -OH, -SH, -C≡N, -NO₂, -NR₁₀₅R'₁₀₅, -CO₂R, -N(R)COR', or -N(R)SO₂R' (where R₁₀₅, R'₁₀₅, R and R' are as defined above), -C(=O)-(C₁-C₄) alkyl, -SO₂-amino, -SO₂-mono or dialkylamino, -C(=O)-amino, -C(=O)-mono or dialkylamino, -SO₂-(C₁-C₄) alkyl, or
30 C_1 - C_6 alkoxy optionally substituted with 1, 2, or 3 groups which are independently selected from halogen, or

C_3 - C_7 cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen,

-OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, -C₁-C₆ alkyl and mono- or dialkylamino, or C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, -C₁-C₃ alkoxy, amino, mono- or dialkylamino and -C₁-C₃ alkyl, or 5 C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl each of which is optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, C₁-C₆ alkyl and 10 mono- or dialkylamino; and the heterocyclyl group is optionally further substituted with oxo.

Preferred compounds of formula I-3 include compounds 15 wherein:

R₁ is -(CH₂)-aryl, -(CH₂)-heteroaryl, or -(CH₂)-heterocyclyl, where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, -OH, -SH, -C≡N, -NO₂, -NR₁₀₅R'₁₀₅, -CO₂R, -N(R)COR', or -N(R)SO₂R' (where R₁₀₅, R'₁₀₅, R and R' are as defined above), -C(=O)-(C₁-C₄) alkyl, -SO₂-amino, -SO₂-mono or dialkylamino, -C(=O)-amino, -C(=O)-mono or dialkylamino, -SO₂-(C₁-C₄) alkyl, or 20 C₁-C₆ alkoxy optionally substituted with 1, 2, or 3 groups which are independently selected from halogen, or 25 C₃-C₇ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, -C₁-C₆ alkyl and mono- or dialkylamino, or 30 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -

OH, -SH, -C≡N, -CF₃, -C₁-C₃ alkoxy, amino, mono- or dialkylamino and -C₁-C₃ alkyl, or C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl each of which is optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, C₁-C₆ alkyl and mono- or dialkylamino; and the heterocyclyl group is optionally further substituted with oxo.

10 Preferred compounds of formula I-3 include compounds
wherein:

R_1 is $-\text{CH}_2\text{-phenyl}$ or $-\text{CH}_2\text{-pyridinyl}$ where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, $C_1\text{-}C_4$ alkoxy, hydroxy, $-\text{NO}_2$, and

15 hydroxy, $-\text{NO}_2$, and
C₁-C₄ alkyl optionally substituted with 1, 2, or 3
substituents independently selected from halogen,
OH, SH, NH₂, NH(C₁-C₆ alkyl), N-(C₁-C₆ alkyl)(C₁-C₆
alkyl), C≡N, CF₃.

20 Preferred compounds of formula I-3 include compounds wherein: R₁ is -CH₂-phenyl or -CH₂-pyridinyl where the phenyl or pyridinyl rings are each optionally substituted with 1 or 2 groups independently selected from halogen, C₁-C₂ alkyl, C₁-C₂ alkoxy, hydroxy, -CF₃, and -NO₂.

25 Preferred compounds of formula I-3 include compounds wherein: R₁ is -CH₂-phenyl where the phenyl ring is optionally substituted with 2 groups independently selected from halogen, C₁-C₂ alkyl, C₁-C₂ alkoxy, hydroxy, and -NO₂.

Preferred compounds of formula I-3 include compounds
30 wherein: R_1 is benzyl, or 3,5-difluorobenzyl.

Preferred compounds of formula I-1, I-2, and I-3 also include compounds of formula I-4, i.e., those of formula I-1, I-2, or I-3 wherein:

R_c is hydrogen, -(CR₂₄₅R₂₅₀)₀₋₄-aryl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl,

5 C₂-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of R₂₀₅, R₁₁₀, R₁₂₀, R₁₃₀, -OC=ONR₂₃₅R₂₄₀, -S(=O)₀₋₂(C₁-C₆ alkyl), -SH, and -S(=O)₂NR₂₃₅R₂₄₀,

10 -(CH₂)₀₋₃-(C₃-C₈) cycloalkyl wherein the cycloalkyl is optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of R₂₀₅, -CO₂H, and -CO₂-(C₁-C₄ alkyl), or

15 C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl, each of which is optionally substituted with 1, 2, or 3 independently selected R₂₀₅ groups, wherein each aryl and heteroaryl is optionally substituted with 1, 2, or 3 R₂₀₀, and wherein each heterocyclyl is 20 optionally substituted with 1, 2, 3, or 4 independently selected R₂₁₀ groups.

Preferred compounds of formula I-4 also include compounds wherein

20 R_c is -(CR₂₄₅R₂₅₀)-aryl, -(CR₂₄₅R₂₅₀)-heteroaryl, -(CR₂₄₅R₂₅₀)-heterocyclyl,

25 C₂-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of R₂₀₅, R₁₁₀, R₁₂₀, R₁₃₀, -OC=ONR₂₃₅R₂₄₀, -S(=O)₀₋₂(C₁-C₆ alkyl), -SH, and -S(=O)₂NR₂₃₅R₂₄₀, wherein each aryl and heteroaryl is optionally substituted with 1, 2, or 3 R₂₀₀, and wherein each heterocyclyl is 30 optionally substituted with 1, 2, 3, or 4 independently selected R₂₁₀ groups.

Preferred compounds of formula I-4 also include compounds wherein

R_c is -(CH₂)-aryl, -(CH₂)-heteroaryl, or

C₂-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₆ alkyl, halogen,

-OH, -O-phenyl, -SH, -S-C₁-C₆ alkyl, -C≡N, -CF₃, C₁-C₆ alkoxy, and NH₂, wherein each aryl and heteroaryl is optionally substituted with 1, 2, or 3 groups selected from OH, -NO₂, halogen, -CO₂H, C≡N, -(CH₂)₀₋₄-CO-NR₂₂₀R₂₂₅, -(CH₂)₀₋₄-CO-(C₁-C₁₂ alkyl), and -(CH₂)₀₋₄-SO₂-NR₂₂₀R₂₂₅.

5 Preferred compounds of formula I-4 also include compounds wherein

R_c is -(CH₂)-phenyl, wherein phenyl is optionally substituted 10 with 1, 2, or 3 groups selected from OH, -NO₂, halogen, -CO₂H, and C≡N, or

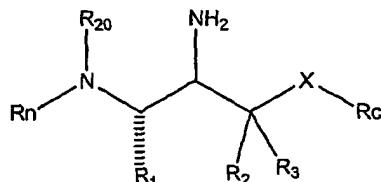
R_c is C₂-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₆ alkyl, halogen, -OH, -C≡N, -CF₃, C₁-C₆ alkoxy, and NH₂.

15 Preferred compounds of formula I-4 also include compounds wherein R_c is benzyl, ethyl, n-propyl, iso-propyl, n-butyl, t-butyl or iso-butyl.

In a preferred embodiment, X is O. In another preferred embodiment, X is S. In yet another preferred embodiment, X is 20 NR₂₀, where R₂₀ is as defined above. In an alternative preferred embodiment, X is NR₂₀NR₂₀, where each R₂₀ is independently as defined above.

In another preferred embodiment, each of R₂, R₃ and R₂₀ are independently hydrogen.

25 A preferred stereochemistry for compounds of formula I is as follows:

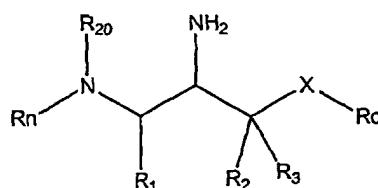


The invention encompasses a method of treating a patient 30 who has, or is preventing a patient from getting, a disease or condition selected from the group consisting of Alzheimer's disease, for helping prevent or delay the onset of Alzheimer's

disease, for treating patients with mild cognitive impairment (MCI) and preventing or delaying the onset of Alzheimer's disease in those who would progress from MCI to AD, for treating Down's syndrome, for treating humans who have 5 Hereditary Cerebral Hemorrhage with Amyloidosis of the Dutch-Type, for treating cerebral amyloid angiopathy and preventing its potential consequences, i.e. single and recurrent lobar hemorrhages, for treating other degenerative dementias, including dementias of mixed vascular and degenerative origin, 10 dementia associated with Parkinson's disease, dementia associated with progressive supranuclear palsy, dementia associated with cortical basal degeneration, diffuse Lewy body type of Alzheimer's disease and who is in need of such treatment which comprises administration of a therapeutically 15 effective amount of a compound selected from the group consisting of a substituted aminoether of the formula (I), or a pharmaceutically acceptable salt or ester thereof.

Preferably, the patient is a human. More preferably, the disease is Alzheimer's disease. More preferably, the disease 20 is dementia.

The invention includes methods for making compounds of formula (I)



25 (I)

or a pharmaceutically acceptable salt or ester thereof, wherein X, R₂₀, R₁, R₂, R₃, R_n and R_c are as defined above or below.

The invention is the compounds of formula (I), which are 30 useful in treating and preventing Alzheimer's disease. The anti-Alzheimer's compounds of formula (I) are made by methods

well known to those skilled in the art from starting compounds known to those skilled in the art. The process chemistry is well known to those skilled in the art. The most general process to prepare compounds of formula (I) of the invention 5 is set forth in Scheme 1. One skilled in the art will appreciate that these are all wellknown reactions in organic chemistry. A chemist skilled in the art, knowing the chemical structure of the biologically end product of formula (I) of the invention would be able to prepare them by known 10 methods from known starting materials without any additional information. The explanation below therefore is not necessary but is deemed helpful to those skilled in the art who desire to make the compounds of the invention.

Scheme 1 sets forth a general method used in the 15 invention to prepare compounds of formula (I). Preparation of the starting epoxide of formula (II), i.e., the Boc-3,5-difluorophenylalanine epoxide, was adapted from the procedure of Luly, JR, et al. *J. Org. Chem.* 1987, 52, 1487-1492. The starting material utilized in the preparation of Boc-3,5- 20 difluorophenylalanine threo epoxide was Boc protected 1-3,5-difluorophenylalanine available from Synthetech, Inc. (1290 Industrial Way, P. O. Box 646, Albany, OR 97321 USA). *Tetrahedron Lett.*, 38, 3175 (1997) further discloses a process 25 for the preparation of N-BOC protected epoxides from protected amino acid esters.

As used herein, PG means "protecting group", and is typically the BOC protecting group ($t\text{Bu-O-C(=O)-}$) or the CBZ protecting group ($\text{Ph-CH}_2\text{-O-C(=O)-}$) may be treated with alcohols of formula (HO-R_C) to afford ring opened products of formula 30 (III). Reactions may be run in organic solvents such as tetrahydrofuran, dimethylsulfoxide, or dimethylformamide at temperatures ranging from room temperature up to the reflux point of the solvent employed. The resulting compound of formula (III) may be isolated by conventional means such as

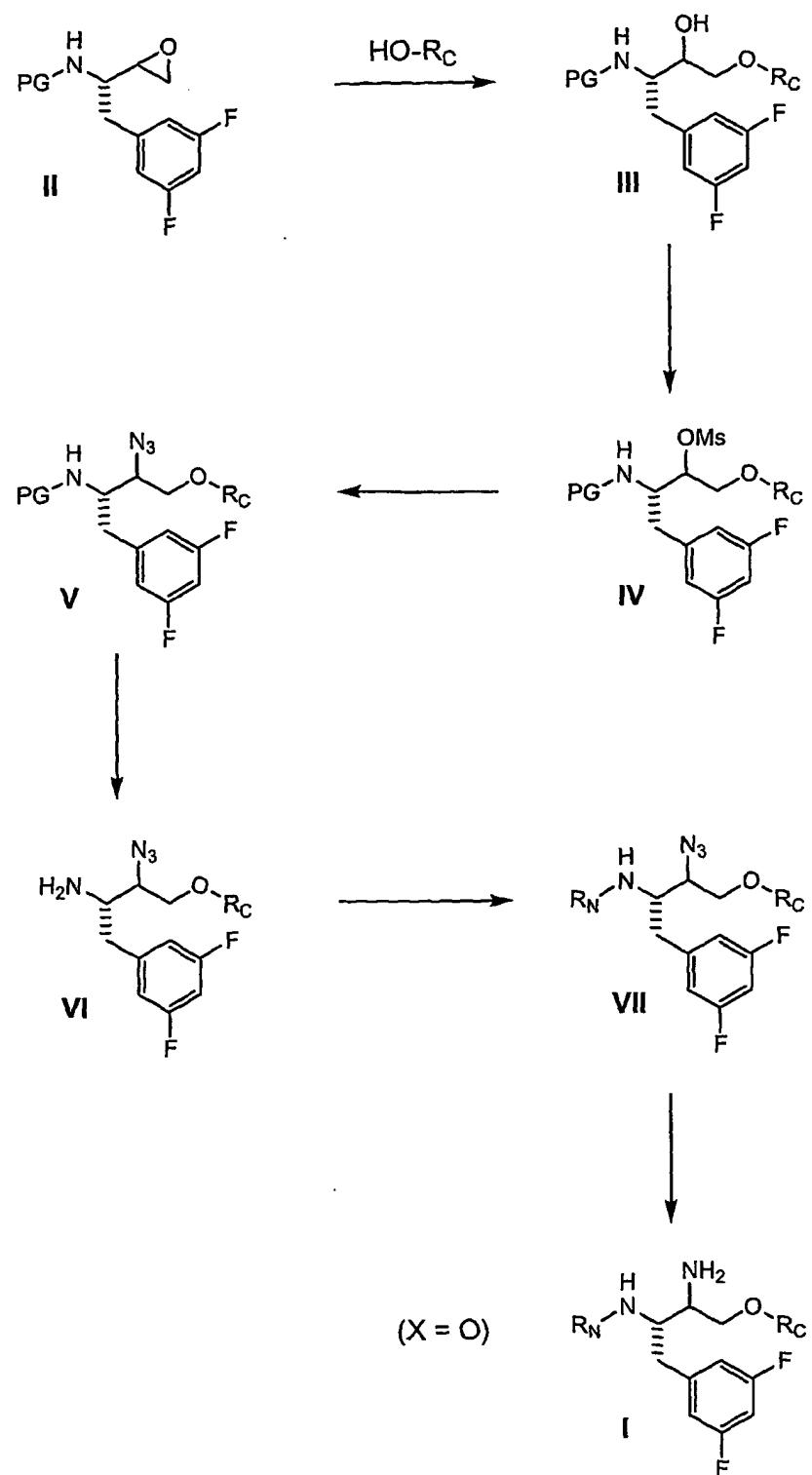
crystallization or chromatography, or it may be used directly in the next step of a synthesis of this invention.

Compounds of formula (III) may be converted to compounds of formula (IV) in the presence of methanesulfonyl chloride in 5 an organic solvent, optimally dichloromethane, in the presence of a base such as di-isopropylethylamine or more preferably triethylamine at a temperature ranging from -78°C (dry ice/acetone) to room temperature.

Compounds of formula (IV) may be converted to compounds 10 of formula (V) by treatment with reagents such as sodium azide in an organic solvent such as dimethylsulfoxide or, more preferably, dimethylformamide at a temperature range of about 50°C to about 120°C. One skilled in synthetic organic chemistry will understand the optimal combination of 15 conditions necessary to effect the desired reaction.

20

25

Scheme I: Preparation of substituted aminoethers

Compounds of formula (V) may be converted to compounds
 5 of formula (VI) via deprotection by means known to those

skilled in the art for removal of amine protecting group. Suitable means for removal of the amine-protecting group depends on the nature of the protecting group. Those skilled in the art, knowing the nature of a specific protecting group, 5 know which reagent is preferable for its removal. For example, it is preferred to remove the preferred protecting group, BOC, by dissolving compound of formula (V) in a trifluoroacetic acid/dichloromethane (1/1) mixture. When complete, the solvents are removed under reduced pressure to 10 give the corresponding amine (as the corresponding salt, i.e. trifluoroacetic acid salt) which is used without further purification. However, if desired, the amine can be purified further by means well known to those skilled in the art, such as for example, recrystallization. Further, if the non-salt 15 form is desired that also can be obtained by means known to those skilled in the art, such as for example, preparing the free base amine via treatment of the salt with mild basic conditions. Additional BOC deprotection conditions and deprotection conditions for other protecting groups can be 20 found in T.W. Green and P.G.M. Wuts in "Protective Groups in Organic Chemistry, John Wiley and Sons, 1991, p. 309. There are numerous methods to remove the representative benzyl-protecting group on the phenol. Preferred methods can be 25 found in T.W. Green and P.G.M. Wuts in "Protecting Groups in Organic Chemistry, John Wiley and Sons, 1999, p. 86.

Compounds of formula (VI) may be converted to compounds of formula (VII) with an appropriately substituted amide forming agent to produce coupled amides by nitrogen-acylation means known to those skilled in the art. Nitrogen acylation 30 conditions for reaction of the amine (VI) with an amide forming agent to produce the corresponding substituted amide (VII) are known to those skilled in the art and can be found in R.C. Larock in Comprehensive Organic Transformations, VCH Publishers, 1989, p. 981, 979, and 972. The nitrogen-

acylation of primary amines to produce secondary amides is one of the oldest known reactions. The amide forming agents are readily prepared according to known starting materials by methods known in the literature. Amide forming reagents are 5 represented by R_N-X_2 wherein X_2 comprises -OH (carboxylic acid) or halide (acyl halide), preferably chlorine, or a suitable group to produce a mixed anhydride.

Compounds of formula (VII) may be converted to compounds of formula (I), wherein $X=O$, in an organic solvent such as 10 methanol or more preferably ethanol in the presence of a catalyst such as 10% palladium on carbon. The reaction is carried out under 1 atmosphere of hydrogen to effect the reduction.

Where it is desired to prepare compounds of formula (I) 15 wherein X is -S-, -NH-, or -NH-NR_A-, one may simply replace the nucleophile HO-R_C in the conversion of compound of formula (II) to compound of formula (III) with the appropriate and desired sulfur or amine nucleophile and following the remaining methods set forth in Scheme 1.

When the amino protecting group is no longer needed, it 20 is removed by methods well known to those skilled in the art. By definition the amino protecting group must be readily removable as is known to those skilled in the art by methods well known to those skilled in the art. Suitable amino 25 protecting group is selected from the group consisting of t-butoxycarbonyl, benzyloxycarbonyl, formyl, trityl, acetyl, trichloroacetyl, dichloroacetyl, chloroacetyl, trifluoroacetyl, difluoroacetyl, fluoroacetyl, 4-phenylbenzyloxycarbonyl, 2-methylbenzyloxycarbonyl, 4-ethoxybenzyloxycarbonyl, 4-fluorobenzyloxycarbonyl, 4-chlorobenzyloxycarbonyl, 3-chlorobenzyloxycarbonyl, 2-chlorobenzyloxycarbonyl, 2,4-dichlorobenzyloxycarbonyl, 4-bromobenzyloxycarbonyl, 3-bromobenzyloxycarbonyl, 4-nitrobenzyloxycarbonyl, 4-cyanobenzyloxycarbonyl, 2-(4-

xenyl)isopropoxycarbonyl, 1,1-diphenyleth-1-yloxycarbonyl,
1,1-diphenylprop-1-yloxycarbonyl, 2-phenylprop-2-
yloxycarbonyl, 2-(*p*-toluyl)prop-2-yloxycarbonyl,
cyclopentanyloxycarbonyl, 1-methylcyclopentanyloxycarbonyl,
5 cyclohexanyloxycarbonyl, 1-methylcyclohexanyloxycarbonyl, 2-
methylcyclohexanyloxycarbonyl, 2-(4-
toluylsulfonyl)ethoxycarbonyl, 2-
(methylsulfonyl)ethoxycarbonyl, 2-
(triphenylphosphino)ethoxycarbonyl, fluorenylmethoxycarbonyl,
10 2-(trimethylsilyl)ethoxycarbonyl, allyloxycarbonyl, 1-
(trimethylsilylmethyl)prop-1-enyloxycarbonyl, 5-
benzisoxalylmethoxycarbonyl, 4-acetoxybenzyloxycarbonyl,
2,2,2-trichloroethoxycarbonyl, 2-ethynyl-2-propoxycarbonyl,
cyclopropylmethoxycarbonyl, 4-(decyloxyl)benzyloxycarbonyl,
15 isobornyloxycarbonyl and 1-piperidyloxycarbonyl, 9-
fluorenylmethyl carbonate,
-CH-CH=CH₂ and phenyl-C(=N)-H.

Suitable means for removal of the amine-protecting group depends on the nature of the protecting group. Those skilled 20 in the art, knowing the nature of a specific protecting group, know which reagent is preferable for its removal. For example, it is preferred to remove the preferred protecting group, BOC, by dissolving the protected material in a trifluoroacetic acid/dichloromethane mixture.

25 The compounds of the invention may contain geometric or optical isomers as well as tautomers. Thus, the invention includes all tautomers and pure geometric isomers, such as the *E* and *Z* geometric isomers, as well as mixtures thereof. Furthermore, the invention includes pure enantiomers and 30 diastereomers as well as mixtures thereof, including racemic mixtures. The individual geometric isomers, enantiomers, or diastereomers may be prepared or isolated by methods known in the art.

Pharmaceutically acceptable salts are any salt which retains the activity of the parent compound and does not impart any deleterious or undesirable effect on the subject to whom it is administered and in the context in which it is administered. Pharmaceutically acceptable salts include salts of both inorganic and organic acids. The preferred pharmaceutically acceptable salts include salts of the following acids acetic, aspartic, benzenesulfonic, benzoic, bicarbonic, bisulfuric, bitartaric, butyric, calcium edetate, camsylic, carbonic, chlorobenzoic, citric, edetic, edisyllic, estolic, esyl, esylic, formic, fumaric, gluceptic, gluconic, glutamic, glycolylarsanilic, hexamic, hexylresorcinic, hydrabamic, hydrobromic, hydrochloric, hydroiodic, hydroxynaphthoic, isethionic, lactic, lactobionic, maleic, malic, malonic, mandelic, methanesulfonic, methylnitric, methylsulfuric, mucic, muconic, napsylic, nitric, oxalic, p-nitromethanesulfonic, pamoic, pantothenic, phosphoric, monohydrogen phosphoric, dihydrogen phosphoric, phthalic, polygalactouronic, propionic, salicylic, stearic, succinic, succinic, sulfamic, sulfanilic, sulfonic, sulfuric, tannic, tartaric, teoclic and toluenesulfonic. For other acceptable salts, see *Int. J. Pharm.*, 33, 201-217 (1986) and *J.Pharm.Sci.*, 66(1), 1, (1977).

The invention provides compounds, compositions, kits, and methods for inhibiting beta-secretase enzyme activity and A beta peptide production: Inhibition of beta-secretase enzyme activity halts or reduces the production of A beta from APP and reduces or eliminates the formation of beta-amyloid deposits in the brain.

30 Methods of the Invention

The compounds of the invention, and pharmaceutically acceptable salts thereof, are useful for treating humans or animals suffering from a condition characterized by a pathological form of beta-amyloid peptide, such as beta-

amyloid plaques, and for helping to prevent or delay the onset of such a condition. For example, the compounds are useful for treating Alzheimer's disease, for helping prevent or delay the onset of Alzheimer's disease, for treating patients with 5 MCI (mild cognitive impairment) and preventing or delaying the onset of Alzheimer's disease in those who would progress from MCI to AD, for treating Down's syndrome, for treating humans who have Hereditary Cerebral Hemorrhage with Amyloidosis of the Dutch-Type, for treating cerebral amyloid angiopathy and 10 preventing its potential consequences, i.e. single and recurrent lobal hemorrhages, for treating other degenerative dementias, including dementias of mixed vascular and degenerative origin, dementia associated with Parkinson's disease, dementia associated with progressive supranuclear 15 palsy, dementia associated with cortical basal degeneration, and diffuse Lewy body type Alzheimer's disease. The compounds and compositions of the invention are particularly useful for treating or preventing Alzheimer's disease. When treating or preventing these diseases, the compounds of the invention can 20 either be used individually or in combination, as is best for the patient.

As used herein, the term "treating" means that the compounds of the invention can be used in humans with at least a tentative diagnosis of disease. The compounds of the 25 invention will delay or slow the progression of the disease thereby giving the individual a more useful life span.

The term "preventing" means that the compounds of the invention are useful when administered to a patient who has not been diagnosed as possibly having the disease at the time 30 of administration, but who would normally be expected to develop the disease or be at increased risk for the disease. The compounds of the invention will slow the development of disease symptoms, delay the onset of the disease, or prevent the individual from developing the disease at all. Preventing

also includes administration of the compounds of the invention to those individuals thought to be predisposed to the disease due to age, familial history, genetic or chromosomal abnormalities, and/or due to the presence of one or more 5 biological markers for the disease, such as a known genetic mutation of APP or APP cleavage products in brain tissues or fluids.

In treating or preventing the above diseases, the compounds of the invention are administered in a 10 therapeutically effective amount. The therapeutically effective amount will vary depending on the particular compound used and the route of administration, as is known to those skilled in the art.

In treating a patient displaying any of the diagnosed 15 above conditions a physician may administer a compound of the invention immediately and continue administration indefinitely, as needed. In treating patients who are not diagnosed as having Alzheimer's disease, but who are believed to be at substantial risk for Alzheimer's disease, the 20 physician should preferably start treatment when the patient first experiences early pre-Alzheimer's symptoms such as, memory or cognitive problems associated with aging. In addition, there are some patients who may be determined to be at risk for developing Alzheimer's through the detection of a 25 genetic marker such as APOE4 or other biological indicators that are predictive for Alzheimer's disease. In these situations, even though the patient does not have symptoms of the disease, administration of the compounds of the invention may be started before symptoms appear, and treatment may be 30 continued indefinitely to prevent or delay the onset of the disease.

Dosage Forms and Amounts

The compounds of the invention can be administered orally, parenterally, (IV, IM, depo-IM, SQ, and depo SQ),

sublingually, intranasally (inhalation), intrathecally, topically, or rectally. Dosage forms known to those of skill in the art are suitable for delivery of the compounds of the invention.

5 Compositions are provided that contain therapeutically effective amounts of the compounds of the invention. The compounds are preferably formulated into suitable pharmaceutical preparations such as tablets, capsules, or elixirs for oral administration or in sterile solutions or
10 suspensions for parenteral administration. Typically the compounds described above are formulated into pharmaceutical compositions using techniques and procedures well known in the art.

About 1 to 500 mg of a compound or mixture of compounds
15 of the invention or a physiologically acceptable salt or ester is compounded with a physiologically acceptable vehicle, carrier, excipient, binder, preservative, stabilizer, flavor, etc., in a unit dosage form as called for by accepted pharmaceutical practice. The amount of active substance in
20 those compositions or preparations is such that a suitable dosage in the range indicated is obtained. The compositions are preferably formulated in a unit dosage form, each dosage containing from about 2 to about 100 mg, more preferably about 10 to about 30 mg of the active ingredient. The term "unit
25 dosage form" refers to physically discrete units suitable as unitary dosages for human subjects and other mammals, each unit containing a predetermined quantity of active material calculated to produce the desired therapeutic effect, in association with a suitable pharmaceutical excipient.

30 To prepare compositions, one or more compounds of the invention are mixed with a suitable pharmaceutically acceptable carrier. Upon mixing or addition of the compound(s), the resulting mixture may be a solution, suspension, emulsion, or the like. Liposomal suspensions may

also be suitable as pharmaceutically acceptable carriers. These may be prepared according to methods known to those skilled in the art. The form of the resulting mixture depends upon a number of factors, including the intended mode of 5 administration and the solubility of the compound in the selected carrier or vehicle. The effective concentration is sufficient for lessening or ameliorating at least one symptom of the disease, disorder, or condition treated and may be empirically determined.

10 Pharmaceutical carriers or vehicles suitable for administration of the compounds provided herein include any such carriers known to those skilled in the art to be suitable for the particular mode of administration. In addition, the active materials can also be mixed with other active materials 15 that do not impair the desired action, or with materials that supplement the desired action, or have another action. The compounds may be formulated as the sole pharmaceutically active ingredient in the composition or may be combined with other active ingredients.

20 Where the compounds exhibit insufficient solubility, methods for solubilizing may be used. Such methods are known and include, but are not limited to, using cosolvents such as dimethylsulfoxide (DMSO), using surfactants such as Tween®, and dissolution in aqueous sodium bicarbonate. Derivatives of 25 the compounds, such as salts or prodrugs may also be used in formulating effective pharmaceutical compositions.

The concentration of the compound is effective for delivery of an amount upon administration that lessens or ameliorates at least one symptom of the disorder for which the 30 compound is administered. Typically, the compositions are formulated for single dosage administration.

The compounds of the invention may be prepared with carriers that protect them against rapid elimination from the body, such as time-release formulations or coatings. Such

carriers include controlled release formulations, such as, but not limited to, microencapsulated delivery systems. The active compound is included in the pharmaceutically acceptable carrier in an amount sufficient to exert a therapeutically useful effect in the absence of undesirable side effects on the patient treated. The therapeutically effective concentration may be determined empirically by testing the compounds in known *in vitro* and *in vivo* model systems for the treated disorder.

The compounds and compositions of the invention can be enclosed in multiple or single dose containers. The enclosed compounds and compositions can be provided in kits, for example, including component parts that can be assembled for use. For example, a compound inhibitor in lyophilized form and a suitable diluent may be provided as separated components for combination prior to use. A kit may include a compound inhibitor and a second therapeutic agent for co-administration. The inhibitor and second therapeutic agent may be provided as separate component parts. A kit may include a plurality of containers, each container holding one or more unit dose of the compound of the invention. The containers are preferably adapted for the desired mode of administration, including, but not limited to tablets, gel capsules, sustained-release capsules, and the like for oral administration; depot products, pre-filled syringes, ampules, vials, and the like for parenteral administration; and patches, medipads, creams, and the like for topical administration.

The concentration of active compound in the drug composition will depend on absorption, inactivation, and excretion rates of the active compound, the dosage schedule, and amount administered as well as other factors known to those of skill in the art.

The active ingredient may be administered at once, or may be divided into a number of smaller doses to be administered at intervals of time. It is understood that the precise dosage and duration of treatment is a function of the disease 5 being treated and may be determined empirically using known testing protocols or by extrapolation from *in vivo* or *in vitro* test data. It is to be noted that concentrations and dosage values may also vary with the severity of the condition to be alleviated. It is to be further understood that for any 10 particular subject, specific dosage regimens should be adjusted over time according to the individual need and the professional judgment of the person administering or supervising the administration of the compositions, and that the concentration ranges set forth herein are exemplary only 15 and are not intended to limit the scope or practice of the claimed compositions.

If oral administration is desired, the compound should be provided in a composition that protects it from the acidic environment of the stomach. For example, the composition can 20 be formulated in an enteric coating that maintains its integrity in the stomach and releases the active compound in the intestine. The composition may also be formulated in combination with an antacid or other such ingredient.

Oral compositions will generally include an inert diluent 25 or an edible carrier and may be compressed into tablets or enclosed in gelatin capsules. For the purpose of oral therapeutic administration, the active compound or compounds can be incorporated with excipients and used in the form of tablets, capsules, or troches. Pharmaceutically compatible 30 binding agents and adjuvant materials can be included as part of the composition.

The tablets, pills, capsules, troches, and the like can contain any of the following ingredients or compounds of a similar nature: a binder such as, but not limited to, gum

tragacanth, acacia, corn starch, or gelatin; an excipient such as microcrystalline cellulose, starch, or lactose; a disintegrating agent such as, but not limited to, alginic acid and corn starch; a lubricant such as, but not limited to, 5 magnesium stearate; a gildant, such as, but not limited to, colloidal silicon dioxide; a sweetening agent such as sucrose or saccharin; and a flavoring agent such as peppermint, methyl salicylate, or fruit flavoring.

When the dosage unit form is a capsule, it can contain, 10 in addition to material of the above type, a liquid carrier such as a fatty oil. In addition, dosage unit forms can contain various other materials, which modify the physical form of the dosage unit, for example, coatings of sugar and other enteric agents. The compounds can also be administered 15 as a component of an elixir, suspension, syrup, wafer, chewing gum or the like. A syrup may contain, in addition to the active compounds, sucrose as a sweetening agent and certain preservatives, dyes and colorings, and flavors.

The active materials can also be mixed with other active 20 materials that do not impair the desired action, or with materials that supplement the desired action.

Solutions or suspensions used for parenteral, 25 intradermal, subcutaneous, or topical application can include any of the following components: a sterile diluent such as water for injection, saline solution, fixed oil, a naturally occurring vegetable oil such as sesame oil, coconut oil, peanut oil, cottonseed oil, and the like, or a synthetic fatty vehicle such as ethyl oleate, and the like, polyethylene glycol, glycerine, propylene glycol, or other synthetic 30 solvent; antimicrobial agents such as benzyl alcohol and methyl parabens; antioxidants such as ascorbic acid and sodium bisulfite; chelating agents such as ethylenediaminetetraacetic acid (EDTA); buffers such as acetates, citrates, and phosphates; and agents for the adjustment of tonicity such as

sodium chloride and dextrose. Parenteral preparations can be enclosed in ampoules, disposable syringes, or multiple dose vials made of glass, plastic, or other suitable material. Buffers, preservatives, antioxidants, and the like can be 5 incorporated as required.

Where administered intravenously, suitable carriers include physiological saline, phosphate buffered saline (PBS), and solutions containing thickening and solubilizing agents such as glucose, polyethylene glycol, polypropylene glycol, and 10 mixtures thereof. Liposomal suspensions including tissue-targeted liposomes may also be suitable as pharmaceutically acceptable carriers. These may be prepared according to methods known for example, as described in U.S. Patent No. 4,522,811.

15 The active compounds may be prepared with carriers that protect the compound against rapid elimination from the body, such as time-release formulations or coatings. Such carriers include controlled release formulations, such as, but not limited to, implants and microencapsulated delivery systems, 20 and biodegradable, biocompatible polymers such as collagen, ethylene vinyl acetate, polyanhydrides, polyglycolic acid, polyorthoesters, polylactic acid, and the like. Methods for preparation of such formulations are known to those skilled in the art.

25 The compounds of the invention can be administered orally, parenterally (IV, IM, depo-IM, SQ, and depo-SQ), sublingually, intranasally (inhalation), intrathecally, topically, or rectally. Dosage forms known to those skilled in the art are suitable for delivery of the compounds of the 30 invention.

Compounds of the invention may be administered enterally or parenterally. When administered orally, compounds of the invention can be administered in usual dosage forms for oral administration as is well known to those skilled in the art.

These dosage forms include the usual solid unit dosage forms of tablets and capsules as well as liquid dosage forms such as solutions, suspensions, and elixirs. When the solid dosage forms are used, it is preferred that they be of the sustained 5 release type so that the compounds of the invention need to be administered only once or twice daily.

The oral dosage forms are administered to the patient 1, 2, 3, or 4 times daily. It is preferred that the compounds of the invention be administered either three or fewer times, more 10 preferably once or twice daily. Hence, it is preferred that the compounds of the invention be administered in oral dosage form. It is preferred that whatever oral dosage form is used, that it be designed so as to protect the compounds of the invention from the acidic environment of the stomach. Enteric 15 coated tablets are well known to those skilled in the art. In addition, capsules filled with small spheres each coated to protect from the acidic stomach, are also well known to those skilled in the art.

When administered orally, an administered amount 20 therapeutically effective to inhibit beta-secretase activity, to inhibit A beta production, to inhibit A beta deposition, or to treat or prevent AD is from about 0.1 mg/day to about 1,000 mg/day. It is preferred that the oral dosage is from about 1 mg/day to about 100 mg/day. It is more preferred that the 25 oral dosage is from about 5 mg/day to about 50 mg/day. It is understood that while a patient may be started at one dose, that dose may be varied over time as the patient's condition changes.

Compounds of the invention may also be advantageously 30 delivered in a nano crystal dispersion formulation. Preparation of such formulations is described, for example, in U.S. Patent 5,145,684. Nano crystalline dispersions of HIV protease inhibitors and their method of use are described in

US 6,045,829. The nano crystalline formulations typically afford greater bioavailability of drug compounds.

The compounds of the invention can be administered parenterally, for example, by IV, IM, depo-IM, SC, or depo-SC.

5 When administered parenterally, a therapeutically effective amount of about 0.5 to about 100 mg/day, preferably from about 5 to about 50 mg daily should be delivered. When a depot formulation is used for injection once a month or once every two weeks, the dose should be about 0.5 mg/day to about 50 10 mg/day, or a monthly dose of from about 15 mg to about 1,500 mg. In part because of the forgetfulness of the patients with Alzheimer's disease, it is preferred that the parenteral dosage form be a depo formulation.

15 The compounds of the invention can be administered sublingually. When given sublingually, the compounds of the invention should be given one to four times daily in the amounts described above for IM administration.

20 The compounds of the invention can be administered intranasally. When given by this route, the appropriate dosage forms are a nasal spray or dry powder, as is known to those skilled in the art. The dosage of the compounds of the invention for intranasal administration is the amount described above for IM administration.

25 The compounds of the invention can be administered intrathecally. When given by this route the appropriate dosage form can be a parenteral dosage form as is known to those skilled in the art. The dosage of the compounds of the invention for intrathecal administration is the amount described above for IM administration.

30 The compounds of the invention can be administered topically. When given by this route, the appropriate dosage form is a cream, ointment, or patch. Because of the amount of the compounds of the invention to be administered, the patch is preferred. When administered topically, the dosage is from

about 0.5 mg/day to about 200 mg/day. Because the amount that can be delivered by a patch is limited, two or more patches may be used. The number and size of the patch is not important, what is important is that a therapeutically effective amount of the compounds of the invention be delivered as is known to those skilled in the art. The compounds of the invention can be administered rectally by suppository as is known to those skilled in the art. When administered by suppository, the therapeutically effective amount is from about 0.5 mg to about 500 mg.

10 The compounds of the invention can be administered by implants as is known to those skilled in the art. When administering a compound of the invention by implant, the therapeutically effective amount is the amount described above
15 for depot administration.

20 The invention here is the new compounds of the invention and new methods of using the compounds of the invention. Given a particular compound of the invention and a desired dosage form, one skilled in the art would know how to prepare and administer the appropriate dosage form.

25 The compounds of the invention are used in the same manner, by the same routes of administration, using the same pharmaceutical dosage forms, and at the same dosing schedule as described above, for preventing disease or treating patients with MCI (mild cognitive impairment) and preventing or delaying the onset of Alzheimer's disease in those who would progress from MCI to AD, for treating or preventing Down's syndrome, for treating humans who have Hereditary Cerebral Hemorrhage with Amyloidosis of the Dutch-Type, for
30 treating cerebral amyloid angiopathy and preventing its potential consequences, i.e. single and recurrent lobar hemorrhages, for treating other degenerative dementias, including dementias of mixed vascular and degenerative origin, dementia associated with Parkinson's disease, dementia

associated with progressive supranuclear palsy, dementia associated with cortical basal degeneration, and diffuse Lewy body type of Alzheimer's disease.

The compounds of the invention can be used in combination, with each other or with other therapeutic agents or approaches used to treat or prevent the conditions listed above. Such agents or approaches include: acetylcholine esterase inhibitors such as tacrine (tetrahydroaminoacridine, marketed as COGNEX®), donepezil hydrochloride, (marketed as 10 Aricept® and rivastigmine (marketed as Exelon®); gamma-secretase inhibitors; anti-inflammatory agents such as cyclooxygenase II inhibitors; anti-oxidants such as Vitamin E and ginkolides; immunological approaches, such as, for example, immunization with A beta peptide or administration of 15 anti-A beta peptide antibodies; statins; and direct or indirect neurotropic agents such as Cerebrolysin®, AIT-082 (Emilieu, 2000, *Arch. Neurol.* 57:454), and other neurotropic agents of the future.

It should be apparent to one skilled in the art that the exact dosage and frequency of administration will depend on the particular compounds of the invention administered, the particular condition being treated, the severity of the condition being treated, the age, weight, general physical condition of the particular patient, and other medication the 25 individual may be taking as is well known to administering physicians who are skilled in this art.

Inhibition of APP Cleavage

The compounds of the invention inhibit cleavage of APP between Met595 and Asp596 numbered for the APP695 isoform, or 30 a mutant thereof, or at a corresponding site of a different isoform, such as APP751 or APP770, or a mutant thereof (sometimes referred to as the "beta secretase site"). While not wishing to be bound by a particular theory, inhibition of beta-secretase activity is thought to inhibit production of

beta amyloid peptide (A beta). Inhibitory activity is demonstrated in one of a variety of inhibition assays, whereby cleavage of an APP substrate in the presence of a beta-secretase enzyme is analyzed in the presence of the inhibitory compound, under conditions normally sufficient to result in cleavage at the beta-secretase cleavage site. Reduction of APP cleavage at the beta-secretase cleavage site compared with an untreated or inactive control is correlated with inhibitory activity. Assay systems that can be used to demonstrate efficacy of the compound inhibitors of the invention are known. Representative assay systems are described, for example, in U.S. Patents No. 5,942,400, 5,744,346, as well as in the Examples below.

The enzymatic activity of beta-secretase and the production of A beta can be analyzed *in vitro* or *in vivo*, using natural, mutated, and/or synthetic APP substrates, natural, mutated, and/or synthetic enzyme, and the test compound. The analysis may involve primary or secondary cells expressing native, mutant, and/or synthetic APP and enzyme, animal models expressing native APP and enzyme, or may utilize transgenic animal models expressing the substrate and enzyme. Detection of enzymatic activity can be by analysis of one or more of the cleavage products, for example, by immunoassay, fluorometric or chromogenic assay, HPLC, or other means of detection. Inhibitory compounds are determined as those having the ability to decrease the amount of beta-secretase cleavage product produced in comparison to a control, where beta-secretase mediated cleavage in the reaction system is observed and measured in the absence of inhibitory compounds.

30 Beta-secretase

Various forms of beta-secretase enzyme are known, and are available and useful for assay of enzyme activity and inhibition of enzyme activity. These include native, recombinant, and synthetic forms of the enzyme. Human beta-

secretase is known as Beta Site APP Cleaving Enzyme (BACE), Asp2, and memapsin 2, and has been characterized, for example, in U.S. Patent No. 5,744,346 and published PCT patent applications WO98/22597, WO00/03819, WO01/23533, and 5 WO00/17369, as well as in literature publications (Hussain et.al., 1999, *Mol.Cell.Neurosci.* 14:419-427; Vassar et.al., 1999, *Science* 286:735-741; Yan et.al., 1999, *Nature* 402:533-537; Sinha et.al., 1999, *Nature* 40:537-540; and Lin et.al., 2000, *PNAS USA* 97:1456-1460). Synthetic forms of the enzyme 10 have also been described (WO98/22597 and WO00/17369). Beta-secretase can be extracted and purified from human brain tissue and can be produced in cells, for example mammalian cells expressing recombinant enzyme.

Preferred compounds are effective to inhibit 50% of beta-secretase enzymatic activity at a concentration of less than about 50 micromolar, preferably at a concentration of less than about 10 micromolar, more preferably less than about 1 micromolar, and most preferably less than about 10 nanomolar.

20 APP Substrate

Assays that demonstrate inhibition of beta-secretase-mediated cleavage of APP can utilize any of the known forms of APP, including the 695 amino acid "normal" isotype described by Kang et.al., 1987, *Nature* 325:733-6, the 770 amino acid 25 isotype described by Kitaguchi et. al., 1981, *Nature* 331:530-532, and variants such as the Swedish Mutation (KM670-1NL) (APP-SW), the London Mutation (V7176F), and others. See, for example, U.S. Patent No. 5,766,846 and also Hardy, 1992, *Nature Genet.* 1:233-234, for a review of known variant 30 mutations. Additional useful substrates include the dibasic amino acid modification, APP-KK disclosed, for example, in WO 00/17369, fragments of APP, and synthetic peptides containing the beta-secretase cleavage site, wild type (WT) or mutated

form, e.g., SW, as described, for example, in U.S. Patent No 5,942,400 and WO00/03819.

The APP substrate contains the beta-secretase cleavage site of APP (KM-DA or NL-DA) for example, a complete APP 5 peptide or variant, an APP fragment, a recombinant or synthetic APP, or a fusion peptide. Preferably, the fusion peptide includes the beta-secretase cleavage site fused to a peptide having a moiety useful for enzymatic assay, for example, having isolation and/or detection properties. A 10 useful moiety may be an antigenic epitope for antibody binding, a label or other detection moiety, a binding substrate, and the like.

Antibodies

Products characteristic of APP cleavage can be measured 15 by immunoassay using various antibodies, as described, for example, in Pirttila et.al., 1999, *Neuro.Lett.* 249:21-4, and in U.S. Pat. No. 5,612,486. Useful antibodies to detect A beta include, for example, the monoclonal antibody 6E10 (Senetek, St. Louis, MO) that specifically recognizes an 20 epitope on amino acids 1-16 of the A beta peptide; antibodies 162 and 164 (New York State Institute for Basic Research, Staten Island, NY) that are specific for human A beta 1-40 and 1-42, respectively; and antibodies that recognize the junction region of beta-amyloid peptide, the site between residues 16 25 and 17, as described in U.S. Patent No. 5,593,846. Antibodies raised against a synthetic peptide of residues 591 to 596 of APP and SW192 antibody raised against 590-596 of the Swedish mutation are also useful in immunoassay of APP and its cleavage products, as described in U.S. Patent Nos. 5,604,102 30 and 5,721,130.

Assay Systems

Assays for determining APP cleavage at the beta-secretase cleavage site are well known in the art. Exemplary assays,

are described, for example, in U.S. Patent Nos. 5,744,346 and 5,942,400, and described in the Examples below.

Cell Free Assays

5 Exemplary assays that can be used to demonstrate the inhibitory activity of the compounds of the invention are described, for example, in WO00/17369, WO 00/03819, and U.S. Patents No. 5,942,400 and 5,744,346. Such assays can be performed in cell-free incubations or in cellular incubations
10 using cells expressing a beta-secretase and an APP substrate having a beta-secretase cleavage site.

An APP substrate containing the beat-secretase cleavage site of APP, for example, a complete APP or variant, an APP fragment, or a recombinant or synthetic APP substrate
15 containing the amino acid sequence: KM-DA or NL-DA, is incubated in the presence of beta-secretase enzyme, a fragment thereof, or a synthetic or recombinant polypeptide variant having beta-secretase activity and effective to cleave the beta-secretase cleavage site of APP, under incubation
20 conditions suitable for the cleavage activity of the enzyme. Suitable substrates optionally include derivatives that may be fusion proteins or peptides that contain the substrate peptide and a modification useful to facilitate the purification or detection of the peptide or its beta-secretase cleavage
25 products. Useful modifications include the insertion of a known antigenic epitope for antibody binding; the linking of a label or detectable moiety, the linking of a binding substrate, and the like.

Suitable incubation conditions for a cell-free *in vitro*
30 assay include, for example: approximately 200 nanomolar to 10 micromolar substrate, approximately 10 to 200 picomolar enzyme, and approximately 0.1 nanomolar to 10 micromolar inhibitor compound, in aqueous solution, at an approximate pH of 4 -7, at approximately 37 degrees C, for a time period of

approximately 10 minutes to 3 hours. These incubation conditions are exemplary only, and can be varied as required for the particular assay components and/or desired measurement system. Optimization of the incubation conditions for the 5 particular assay components should account for the specific beta-secretase enzyme used and its pH optimum, any additional enzymes and/or markers that might be used in the assay, and the like. Such optimization is routine and will not require undue experimentation.

10 One useful assay utilizes a fusion peptide having maltose binding protein (MBP) fused to the C-terminal 125 amino acids of APP-SW. The MBP portion is captured on an assay substrate by anti-MBP capture antibody. Incubation of the captured fusion protein in the presence of beta-secretase results in 15 cleavage of the substrate at the beta-secretase cleavage site. Analysis of the cleavage activity can be, for example, by immunoassay of cleavage products. One such immunoassay detects a unique epitope exposed at the carboxy terminus of the cleaved fusion protein, for example, using the antibody 20 SW192. This assay is described, for example, in U.S. Patent No 5,942,400.

Cellular Assay

Numerous cell-based assays can be used to analyze beta-secretase activity and/or processing of APP to release A beta. 25 Contact of an APP substrate with a beta-secretase enzyme within the cell and in the presence or absence of a compound inhibitor of the invention can be used to demonstrate beta-secretase inhibitory activity of the compound. Preferably, assay in the presence of a useful inhibitory compound provides 30 at least about 30%, most preferably at least about 50% inhibition of the enzymatic activity, as compared with a non-inhibited control.

In one embodiment, cells that naturally express beta-secretase are used. Alternatively, cells are modified to

express a recombinant beta-secretase or synthetic variant enzyme as discussed above. The APP substrate may be added to the culture medium and is preferably expressed in the cells. Cells that naturally express APP, variant or mutant forms of 5 APP, or cells transformed to express an isoform of APP, mutant or variant APP, recombinant or synthetic APP, APP fragment, or synthetic APP peptide or fusion protein containing the beta-secretase APP cleavage site can be used, provided that the expressed APP is permitted to contact the enzyme and enzymatic 10 cleavage activity can be analyzed.

Human cell lines that normally process A beta from APP provide a useful means to assay inhibitory activities of the compounds of the invention. Production and release of A beta and/or other cleavage products into the culture medium can be 15 measured, for example by immunoassay, such as Western blot or enzyme-linked immunoassay (EIA) such as by ELISA.

Cells expressing an APP substrate and an active beta-secretase can be incubated in the presence of a compound inhibitor to demonstrate inhibition of enzymatic activity as 20 compared with a control. Activity of beta-secretase can be measured by analysis of one or more cleavage products of the APP substrate. For example, inhibition of beta-secretase activity against the substrate APP would be expected to decrease release of specific beta-secretase induced APP 25 cleavage products such as A beta.

Although both neural and non-neural cells process and release A beta, levels of endogenous beta-secretase activity are low and often difficult to detect by EIA. The use of cell types known to have enhanced beta-secretase activity, enhanced 30 processing of APP to A beta, and/or enhanced production of A beta are therefore preferred. For example, transfection of cells with the Swedish Mutant form of APP (APP-SW); with APP-KK; or with APP-SW-KK provides cells having enhanced beta-

secretase activity and producing amounts of A beta that can be readily measured.

In such assays, for example, the cells expressing APP and beta-secretase are incubated in a culture medium under 5 conditions suitable for beta-secretase enzymatic activity at its cleavage site on the APP substrate. On exposure of the cells to the compound inhibitor, the amount of A beta released into the medium and/or the amount of CTF99 fragments of APP in the cell lysates is reduced as compared with the control. The 10 cleavage products of APP can be analyzed, for example, by immune reactions with specific antibodies, as discussed above.

Preferred cells for analysis of beta-secretase activity include primary human neuronal cells, primary transgenic animal neuronal cells where the transgene is APP, and other 15 cells such as those of a stable 293 cell line expressing APP, for example, APP-SW.

In Vivo Assays: Animal Models

Various animal models can be used to analyze beta-secretase activity and /or processing of APP to release A 20 beta, as described above. For example, transgenic animals expressing APP substrate and beta-secretase enzyme can be used to demonstrate inhibitory activity of the compounds of the invention. Certain transgenic animal models have been described, for example, in U.S. Patent Nos: 5,877,399; 25 5,612,486; 5,387,742; 5,720,936; 5,850,003; 5,877,015,, and 5,811,633, and in Ganes et.al., 1995, *Nature* 373:523. Preferred are animals that exhibit characteristics associated 30 with the pathophysiology of AD. Administration of the compound inhibitors of the invention to the transgenic mice described herein provides an alternative method for demonstrating the inhibitory activity of the compounds. Administration of the compounds in a pharmaceutically effective carrier and via an administrative route that reaches

the target tissue in an appropriate therapeutic amount is also preferred.

Inhibition of beta-secretase mediated cleavage of APP at the beta-secretase cleavage site and of A beta release can be 5 analyzed in these animals by measure of cleavage fragments in the animal's body fluids such as cerebral fluid or tissues. Analysis of brain tissues for A beta deposits or plaques is preferred.

On contacting an APP substrate with a beta-secretase enzyme in the presence of an inhibitory compound of the invention and under conditions sufficient to permit enzymatic mediated cleavage of APP and/or release of A beta from the substrate, the compounds of the invention are effective to reduce beta-secretase-mediated cleavage of APP at the beta-secretase cleavage site and/or effective to reduce released amounts of A beta. Where such contacting is the administration of the inhibitory compounds of the invention to an animal model, for example, as described above, the compounds are effective to reduce A beta deposition in brain 10 tissues of the animal, and to reduce the number and/or size of beta amyloid plaques. Where such administration is to a human subject, the compounds are effective to inhibit or slow the progression of disease characterized by enhanced amounts of A beta, to slow the progression of AD in the, and/or to prevent 15 onset or development of AD in a patient at risk for the disease.

Unless defined otherwise, all scientific and technical terms used herein have the same meaning as commonly understood by one of skill in the art to which this invention belongs. 20 All patents and publications referred to herein are hereby incorporated by reference for all purposes.

Definitions and Conventions

The definitions and explanations below are for the terms as used throughout this entire document including both the specification and the claims.

Definitions

- 5 All temperatures are in degrees Celsius.
- TLC refers to thin-layer chromatography.
- psi refers to pounds/in².
- HPLC refers to high pressure liquid chromatography.
- 10 THF refers to tetrahydrofuran.
- DMF refers to dimethylformamide.
- 15 EDC refers to ethyl-1-(3-dimethylaminopropyl)carbodiimide or 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride.
- HOBt refers to 1-hydroxy benzotriazole hydrate.
- NMM refers to N-methylmorpholine.
- NBS refers to N-bromosuccinimide.
- TEA refers to triethylamine.
- 20 BOC refers to 1,1-dimethylethoxy carbonyl or t-butoxycarbonyl, represented schematically as-CO-O-C(CH₃)₃.
- CBZ refers to benzyloxycarbonyl, -CO-O-CH₂-φ.
- FMOC refers to 9-fluorenylmethyl carbonate.
- TFA refers to trifluoracetic acid, CF₃-COOH.
- 25 CDI refers to 1,1'-carbonyldiimidazole.
- Saline refers to an aqueous saturated sodium chloride solution.
- 30 Chromatography (column and flash chromatography) refers to purification/separation of compounds expressed as (support, eluent). It is understood that the appropriate fractions are pooled and concentrated to give the desired compound(s).
- CMR refers to C-13 magnetic resonance spectroscopy, chemical shifts are reported in ppm (δ) downfield from TMS.

NMR refers to nuclear (proton) magnetic resonance spectroscopy, chemical shifts are reported in ppm (d) downfield from TMS.

IR refers to infrared spectroscopy.

5 -phenyl refers to phenyl (C₆H₅).

MS refers to mass spectrometry expressed as m/e, m/z or mass/charge unit. MH⁺ refers to the positive ion of a parent plus a hydrogen atom. EI refers to electron impact. CI refers to chemical ionization. FAB refers to fast atom 10 bombardment.

HRMS refers to high resolution mass spectrometry.

Ether refers to diethyl ether.

When solvent pairs are used, the ratios of solvents used are volume/volume (v/v).

15 When the solubility of a solid in a solvent is used the ratio of the solid to the solvent is weight/volume (wt/v).

BOP refers to benzotriazol-1-yloxy-tris(dimethylamino)phosphonium hexafluorophosphate.

TBDMSCl refers to t-butyldimethylsilyl chloride.

20 TBDMSOTf refers to t-butyldimethylsilyl trifluosulfonic acid ester.

Trisomy 21 refers to Down's Syndrome.

APP, amyloid precursor protein, is defined as any APP polypeptide, including APP variants, mutations, and isoforms, 25 for example, as disclosed in U.S. Patent No. 5,766,846.

A beta, amyloid beta peptide, is defined as any peptide resulting from beta-secretase mediated cleavage of APP, including peptides of 39, 40, 41, 42, and 43 amino acids, and extending from the beta-secretase cleavage site to amino acids 30 39, 40, 41, 42, or 43.

Beta-secretase (BACE1, Asp2, Memapsin 2) is an aspartyl protease that mediates cleavage of APP at the amino-terminal edge of A beta. Human beta-secretase is described, for example, in WO00/17369.

By "alkyl" and "C₁-C₆ alkyl" in the invention is meant straight or branched chain alkyl groups having 1-6 carbon atoms, such as, methyl, ethyl, propyl, isopropyl, n-butyl, sec-butyl, tert-butyl, pentyl, 2-pentyl, isopentyl, neopentyl, 5 hexyl, 2-hexyl, 3-hexyl, and 3-methylpentyl. It is understood that in cases where an alkyl chain of a substituent (e.g. of an alkyl, alkoxy or alkenyl group) is shorter or longer than 6 carbons, it will be so indicated in the second "C" as, for example, "C₁-C₁₀" indicates a maximum of 10 carbons.

10 By "alkoxy" and "C₁-C₆ alkoxy" in the invention is meant straight or branched chain alkyl groups having 1-6 carbon atoms, attached through at least one divalent oxygen atom, such as, for example, methoxy, ethoxy, propoxy, isopropoxy, n-butoxy, sec-butoxy, tert-butoxy, pentoxy, isopentoxy, 15 neopentoxy, hexoxy, and 3-methylpentoxy.

By the term "halogen" in the invention is meant fluorine, bromine, chlorine, and iodine.

"Alkenyl" and "C₂-C₆ alkenyl" means straight and branched hydrocarbon radicals having from 2 to 6 carbon atoms and from 20 one to three double bonds and includes, for example, ethenyl, propenyl, 1-but-3-enyl, 1-pent-3-enyl, 1-hex-5-enyl and the like.

"Alkynyl" and "C₂-C₆ alkynyl" means straight and branched hydrocarbon radicals having from 2 to 6 carbon atoms and one 25 or two triple bonds and includes ethynyl, propynyl, butynyl, pentyn-2-yl and the like.

As used herein, the term "cycloalkyl" refers to saturated carbocyclic radicals having three to twelve carbon atoms. The cycloalkyl can be monocyclic, or a polycyclic fused system. 30 Examples of such radicals include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and cycloheptyl. The cycloalkyl groups herein are unsubstituted or, as specified, substituted in one or more substitutable positions with various groups. For example, such cycloalkyl groups may be optionally

substituted with C_1 - C_6 alkyl, C_1 - C_6 alkoxy, halogen, hydroxy, cyano, nitro, amino, mono(C_1 - C_6)alkylamino, di(C_1 - C_6)alkylamino, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_1 - C_6 haloalkyl, C_1 - C_6 haloalkoxy, amino(C_1 - C_6)alkyl, mono(C_1 - C_6)alkylamino(C_1 - C_6)alkyl or di(C_1 - C_6)alkylamino(C_1 - C_6)alkyl.

By "aryl" is meant an aromatic carbocyclic group having a single ring (e.g., phenyl), multiple rings (e.g., biphenyl), or multiple condensed rings in which at least one is aromatic, (e.g., 1,2,3,4-tetrahydronaphthyl, naphthyl), which is 10 optionally mono-, di-, or trisubstituted. Preferred aryl groups of the invention are phenyl, 1-naphthyl, 2-naphthyl, indanyl, indenyl, dihydronaphthyl, tetralinyl or 6,7,8,9-tetrahydro-5H-benzo[a]cycloheptenyl. The aryl groups herein are unsubstituted or, as specified, substituted in one or more 15 substitutable positions with various groups. For example, such aryl groups may be optionally substituted with, for example, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, halogen, hydroxy, cyano, nitro, amino, mono(C_1 - C_6)alkylamino, di(C_1 - C_6)alkylamino, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_1 - C_6 haloalkyl, C_1 - C_6 haloalkoxy, 20 amino(C_1 - C_6)alkyl, mono(C_1 - C_6)alkylamino(C_1 - C_6)alkyl, di(C_1 - C_6)alkylamino(C_1 - C_6)alkyl, -COOH, -C(=O)O(C_1 - C_6 alkyl), -C(=O)NH₂, -C(=O)N(mono- or di- C_1 - C_6 alkyl), -S(C_1 - C_6 alkyl), -SO₂(C_1 - C_6 alkyl), -O-C(=O)(C_1 - C_6 alkyl), -NH-C(=O)-(C₁-C₆ alkyl), -N(C₁-C₆ alkyl)-C(=O)-(C₁-C₆ alkyl), -NH-SO₂-(C₁-C₆ alkyl), -N(C₁-C₆ alkyl)-SO₂-(C₁-C₆ alkyl), -NH-C(=O)NH₂, -NH-C(=O)N(mono- or di- C_1 - C_6 alkyl), -NH(C₁-C₆ alkyl)-C(=O)-NH₂ or 25 -NH(C₁-C₆ alkyl)-C(=O)-N-(mono- or di- C_1 - C_6 alkyl).

By "heteroaryl" is meant one or more aromatic ring systems of 5-, 6-, or 7-membered rings which includes fused 30 ring systems of 9-11 atoms containing at least one and up to four heteroatoms selected from nitrogen, oxygen, or sulfur. Preferred heteroaryl groups of the invention include pyridinyl, pyrimidinyl, quinolinyl, benzothienyl, indolyl, indolinyl, pyridazinyl, pyrazinyl, isoindolyl, isoquinolyl,

quinazolinyl, quinoxalinyl, phthalazinyl, imidazolyl,
isoxazolyl, pyrazolyl, oxazolyl, thiazolyl, indolizinyl,
indazolyl, benzothiazolyl, benzimidazolyl, benzofuranyl,
furanyl, thienyl, pyrrolyl, oxadiazolyl, thiadiazolyl,
5 triazolyl, tetrazolyl, oxazolopyridinyl, imidazopyridinyl,
isothiazolyl, naphthyridinyl, cinnolinyl, carbazolyl, beta-
carbolinyl, isochromanyl, chromanyl, tetrahydroisoquinolinyl,
isoindolinyl, isobenzotetrahydrofuranyl,
isobenzotetrahydrothienyl, isobenzothienyl, benzoxazolyl,
10 pyridopyridinyl, benzotetrahydrofuranyl,
benzotetrahydrothienyl, purinyl, benzodioxolyl, triazinyl,
phenoazinyl, phenothiazinyl, pteridinyl, benzothiazolyl,
imidazopyridinyl, imidazothiazolyl, dihydrobenzisoxazinyl,
benzisoxazinyl, benzoxazinyl, dihydrobenzisothiazinyl,
15 benzopyranyl, benzothiopyranyl, coumarinyl, isocoumarinyl,
chromonyl, chromanonyl, pyridinyl-N-oxide,
tetrahydroquinolinyl, dihydroquinolinyl, dihydroquinolinonyl,
dihydroisoquinolinonyl, dihydrocoumarinyl,
dihydroisocoumarinyl, isoindolinonyl, benzodioxanyl,
20 benzoxazolinonyl, pyrrolyl N-oxide, pyrimidinyl N-oxide,
pyridazinyl N-oxide, pyrazinyl N-oxide, quinolinyl N-oxide,
indolyl N-oxide, indolinyl N-oxide, isoquinolyl N-oxide,
quinazolinyl N-oxide, quinoxalinyl N-oxide, phthalazinyl N-
oxide, imidazolyl N-oxide, isoxazolyl N-oxide, oxazolyl N-
25 oxide, thiazolyl N-oxide, indolizinyl N-oxide, indazolyl N-
oxide, benzothiazolyl N-oxide, benzimidazolyl N-oxide, pyrrolyl
N-oxide, oxadiazolyl N-oxide, thiadiazolyl N-oxide, triazolyl
N-oxide, tetrazolyl N-oxide, benzothiopyranyl S-oxide,
benzothiopyranyl S,S-dioxide. The heteroaryl groups herein
30 are unsubstituted or, as specified, substituted in one or more
substitutable positions with various groups. For example,
such heteroaryl groups may be optionally substituted with C₁-C₆
alkyl, C₁-C₆ alkoxy, halogen, hydroxy, cyano, nitro, amino,
mono(C₁-C₆)alkylamino, di(C₁-C₆)alkylamino, C₂-C₆alkenyl, C₂-

C_6 alkynyl, C_1 - C_6 haloalkyl, C_1 - C_6 haloalkoxy, amino(C_1 - C_6)alkyl, mono(C_1 - C_6)alkylamino(C_1 - C_6)alkyl or di(C_1 - C_6)alkylamino(C_1 - C_6)alkyl, -COOH, -C(=O)O(C_1 - C_6 alkyl), -C(=O)NH₂, -C(=O)N(mono- or di- C_1 - C_6 alkyl), -S(C_1 - C_6 alkyl), -SO₂(C_1 - C_6 alkyl), -O-
5 -C(=O)(C_1 - C_6 alkyl), -NH-C(=O)-(C₁-C₆ alkyl), -N(C_1 - C_6 alkyl)-C(=O)-(C₁-C₆ alkyl), -NH-SO₂-(C_1 - C_6 alkyl), -N(C_1 - C_6 alkyl)-SO₂-(C_1 - C_6 alkyl), -NH-C(=O)NH₂, -NH-C(=O)N(mono- or di- C_1 - C_6 alkyl), -NH(C_1 - C_6 alkyl)-C(=O)-NH₂ or -NH(C_1 - C_6 alkyl)-C(=O)-N-(mono- or di- C_1 - C_6 alkyl).

10 By "heterocycle", "heterocycloalkyl" or "heterocyclyl" is meant one or more carbocyclic ring systems of 4-, 5-, 6-, or 7-membered rings which includes fused ring systems of 9-11 atoms containing at least one and up to four heteroatoms selected from nitrogen, oxygen, or sulfur. Preferred
15 heterocycles of the invention include morpholinyl, thiomorpholinyl, thiomorpholinyl S-oxide, thiomorpholinyl S,S-dioxide, piperazinyl, homopiperazinyl, pyrrolidinyl, pyrrolinyl, tetrahydropyranyl, piperidinyl, tetrahydrofuranyl, tetrahydrothienyl, homopiperidinyl, homomorpholinyl,
20 homothiomorpholinyl, homothiomorpholinyl S,S-dioxide, oxazolidinonyl, dihydropyrazolyl, dihydropyrrolyl, dihydropyrazinyl, dihydropyridinyl, dihydropyrimidinyl, dihydrafuryl, dihydropyranyl, tetrahydrothienyl S-oxide, tetrahydrothienyl S,S-dioxide and homothiomorpholinyl S-oxide.
25 The heterocycle groups herein are unsubstituted or, as specified, substituted in one or more substitutable positions with various groups. For example, such heterocycle groups may be optionally substituted with C_1 - C_6 alkyl, C_1 - C_6 alkoxy, halogen, hydroxy, cyano, nitro, amino, mono(C_1 - C_6)alkylamino,
30 di(C_1 - C_6)alkylamino, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_1 - C_6 haloalkyl, C_1 - C_6 haloalkoxy, amino(C_1 - C_6)alkyl, mono(C_1 - C_6)alkylamino(C_1 - C_6)alkyl, di(C_1 - C_6)alkylamino(C_1 - C_6)alkyl or =O.

"Pharmaceutically acceptable" refers to those properties and/or substances that are acceptable to the patient from a

pharmacological/toxicological point of view and to the manufacturing pharmaceutical chemist from a physical/chemical point of view regarding composition, formulation, stability, patient acceptance and bioavailability.

5 A therapeutically effective amount is defined as an amount effective to reduce or lessen at least one symptom of the disease being treated or to reduce or delay onset of one or more clinical markers or symptoms of the disease.

10 It should be noted that, as used in this specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the content clearly dictates otherwise. Thus, for example, reference to a composition containing "a compound" includes a mixture of two or more compounds. It should also be noted that the term "or" 15 is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

Unless defined otherwise, all scientific and technical terms used herein have the same meaning as commonly understood by one of skill in the art to which this invention belongs.

20 All patents and publications referred to herein are hereby incorporated by reference for all purposes.

BIOLOGY EXAMPLES

Example A

25 **Enzyme Inhibition Assay**

The compounds of the invention are analyzed for inhibitory activity by use of the MBP-C125 assay. This assay determines the relative inhibition of beta-secretase cleavage of a model APP substrate, MBP-C125SW, by the compounds assayed 30 as compared with an untreated control. A detailed description of the assay parameters can be found, for example, in U.S. Patent No. 5,942,400. Briefly, the substrate is a fusion peptide formed of maltose binding protein (MBP) and the carboxy terminal 125 amino acids of APP-SW, the Swedish

mutation. The beta-secretase enzyme is derived from human brain tissue as described in Sinha et.al, 1999, *Nature* 40:537-540) or recombinantly produced as the full-length enzyme (amino acids 1-501), and can be prepared, for example, from 5 293 cells expressing the recombinant cDNA, as described in WO00/47618. Human brain β -Secretase from concentrated HiQ pool prepared 7/16/97 in 0.20% Triton was used in the assay. Inhibition of the enzyme is analyzed, for example, by immunoassay of the enzyme's cleavage products. One exemplary 10 ELISA uses an anti-MBP capture antibody that is deposited on precoated and blocked 96-well high binding plates, followed by incubation with diluted enzyme reaction supernatant, incubation with a specific reporter antibody, for example, biotinylated anti-SW192 reporter antibody, and further 15 incubation with streptavidin/alkaline phosphatase. In the assay, cleavage of the intact MBP-C125SW fusion protein results in the generation of a truncated amino-terminal fragment, exposing a new SW-192 antibody-positive epitope at the carboxy terminus. Detection is effected by a fluorescent 20 substrate signal on cleavage by the phosphatase. ELISA only detects cleavage following Leu 596 at the substrate's APP-SW 751 mutation site.

Specific Assay Procedure:

Compounds are diluted in a 1:1 dilution series to a six- 25 point concentration curve (two wells per concentration) in one 96-plate row per compound tested. Each of the test compounds is prepared in DMSO to make up a 10 millimolar stock solution. The stock solution is serially diluted in DMSO to obtain a final compound concentration of 200 micromolar at the high 30 point of a 6-point dilution curve. Ten (10) microliters of each dilution is added to each of two wells on row C of a corresponding V-bottom plate to which 190 microliters of 52 millimolar NaOAc, 7.9% DMSO, pH 4.5 are pre-added. The NaOAc diluted compound plate is spun down to pellet precipitant and

20 microliters/well is transferred to a corresponding flat-bottom plate to which 30 microliters of ice-cold enzyme-substrate mixture (2.5 microliters MBP-C125SW substrate, 0.03 microliters enzyme and 24.5 microliters ice cold 0.09% TX100 per 30 microliters) is added. The final reaction mixture of 200 micromolar compound at the highest curve point is in 5% DMSO, 20 millimolar NaAc, 0.06% TX100, at pH 4.5.

Warming the plates to 37 degrees C starts the enzyme reaction. After 90 minutes at 37 degrees C, 200 microliters/well cold specimen diluent is added to stop the reaction and 20 microliters/well was transferred to a corresponding anti-MBP antibody coated ELISA plate for capture, containing 80 microliters/well specimen diluent. This reaction is incubated overnight at 4 degrees C and the 15 ELISA is developed the next day after a 2 hour incubation with anti-192SW antibody, followed by Streptavidin-AP conjugate and fluorescent substrate. The signal is read on a fluorescent plate reader.

Relative compound inhibition potency is determined by 20 calculating the concentration of compound that showed a fifty percent reduction in detected signal (IC_{50}) compared to the enzyme reaction signal in the control wells with no added compound.

Example B

25 Cell Free Inhibition Assay Utilizing a Synthetic APP Substrate

A synthetic APP substrate that can be cleaved by beta-secretase and having N-terminal biotin and made fluorescent by the covalent attachment of Oregon green at the Cys residue is 30 used to assay beta-secretase activity in the presence or absence of the inhibitory compounds of the invention. Useful substrates include the following:

Biotin-SEVNL-DAEFRC [oregon green] KK [SEQ ID NO:
1]
Biotin-SEVKM-DAEFRC [oregon green] KK [SEQ ID NO:
2]
Biotin-GLNIKTEEISEISY-EVEFRC [oregon green] KK [SEQ ID NO:
5]
Biotin-ADRGTLTRPGSGLTNIKTEEISEVNL-DAEFRC [oregon green] KK
[SEQ ID NO:4]
Biotin-FVNQHLCoxGSHLVEALY-LVCoxGERGFFYTPKAC [oregon
10 green] KK [SEQ ID NO: 5]

The enzyme (0.1 nanomolar) and test compounds (0.001 - 100 micromolar) are incubated in pre-blocked, low affinity, black plates (384 well) at 37 degrees for 30 minutes. The reaction is initiated by addition of 150 millimolar substrate to a final volume of 30 microliter per well. The final assay conditions are: 0.001 - 100 micromolar compound inhibitor; 0.1 molar sodium acetate (pH 4.5); 150 nanomolar substrate; 0.1 nanomolar soluble beta-secretase; 0.001% Tween 20, and 2% DMSO. The assay mixture is incubated for 3 hours at 37 degrees C, and the reaction is terminated by the addition of a saturating concentration of immunopure streptavidin. After incubation with streptavidin at room temperature for 15 minutes, fluorescence polarization is measured, for example, using a L JL Acqurest (Ex485 nm/ Em530 nm). The activity of the beta-secretase enzyme is detected by changes in the fluorescence polarization that occur when the substrate is cleaved by the enzyme. Incubation in the presence or absence of compound inhibitor demonstrates specific inhibition of beta-secretase enzymatic cleavage of its synthetic APP substrate. In this assay, preferred compounds of the invention exhibit an IC₅₀ of less than 50 micromolar.

Example C

Beta-Secretase Inhibition: P26-P4'SW Assay

Synthetic substrates containing the beta-secretase cleavage site of APP are used to assay beta-secretase activity, using the methods described, for example, in published PCT application WO00/47618. The P26-P4'SW substrate 5 is a peptide of the sequence:

(biotin) CGGADRGLTTRPGSGLTNIKTEEISEVNLD AEF [SEQ ID NO: 6]

The P26-P1 standard has the sequence:

(biotin) CGGADRGLTTRPGSGLTNIKTEEISEVN L [SEQ ID NO: 7].

Briefly, the biotin-coupled synthetic substrates are 10 incubated at a concentration of from about 0 to about 200 micromolar in this assay. When testing inhibitory compounds, a substrate concentration of about 1.0 micromolar is preferred. Test compounds diluted in DMSO are added to the reaction mixture, with a final DMSO concentration of 5%. 15 Controls also contain a final DMSO concentration of 5%. The concentration of beta secretase enzyme in the reaction is varied, to give product concentrations with the linear range of the ELISA assay, about 125 to 2000 picomolar, after dilution.

20 The reaction mixture also includes 20 millimolar sodium acetate, pH 4.5, 0.06% Triton X100, and is incubated at 37 degrees C for about 1 to 3 hours. Samples are then diluted in assay buffer (for example, 145.4 nanomolar sodium chloride, 9.51 millimolar sodium phosphate, 7.7 millimolar sodium azide, 25 0.05% Triton X405, 6g/liter bovine serum albumin, pH 7.4) to quench the reaction, then diluted further for immunoassay of the cleavage products.

Cleavage products can be assayed by ELISA. Diluted samples and standards are incubated in assay plates coated 30 with capture antibody, for example, SW192, for about 24 hours at 4 degrees C. After washing in TTBS buffer (150 millimolar sodium chloride, 25 millimolar Tris, 0.05% Tween 20, pH 7.5), the samples are incubated with streptavidin-AP according to the manufacturer's instructions. After a one hour incubation

at room temperature, the samples are washed in TTBS and incubated with fluorescent substrate solution A (31.2 g/liter 2-amino-2-methyl-1-propanol, 30 mg/liter, pH 9.5). Reaction with streptavidin-alkaline phosphate permits detection by 5 fluorescence. Compounds that are effective inhibitors of beta-secretase activity demonstrate reduced cleavage of the substrate as compared to a control.

Example D

10 **Assays using Synthetic Oligopeptide-Substrates**

Synthetic oligopeptides are prepared that incorporate the known cleavage site of beta-secretase, and optionally detectable tags, such as fluorescent or chromogenic moieties. Examples of such peptides, as well as their production and 15 detection methods are described in U.S. Patent No: 5,942,400, herein incorporated by reference. Cleavage products can be detected using high performance liquid chromatography, or fluorescent or chromogenic detection methods appropriate to the peptide to be detected, according to methods well known in 20 the art.

By way of example, one such peptide has the sequence SEVNL-DAEF . [SEQ ID NO: 8], and the cleavage site is between residues 5 and 6. Another preferred substrate has the sequence ADRGLTTRPGSGLTNIKTEEISEVNL-DAEF [SEQ ID NO: 9], and 25 the cleavage site is between residues 26 and 27.

These synthetic APP substrates are incubated in the presence of beta-secretase under conditions sufficient to result in beta-secretase mediated cleavage of the substrate. Comparison of the cleavage results in the presence of the 30 compound inhibitor to control results provides a measure of the compound's inhibitory activity.

Example E

Inhibition of Beta-Secretase Activity - Cellular Assay

An exemplary assay for the analysis of inhibition of beta-secretase activity utilizes the human embryonic kidney cell line HEKp293 (ATCC Accession No. CRL-1573) transfected with APP751 containing the naturally occurring double mutation 5 Lys651Met52 to Asn651Leu652 (numbered for APP751), commonly called the Swedish mutation and shown to overproduce A beta (Citron et al., 1992, *Nature* 360:672-674), as described in U.S. Patent No. 5,604,102.

The cells are incubated in the presence/absence of the 10 inhibitory compound (diluted in DMSO) at the desired concentration, generally up to 10 micrograms/ml. At the end of the treatment period, conditioned media is analyzed for beta-secretase activity, for example, by analysis of cleavage fragments. A beta can be analyzed by immunoassay, using 15 specific detection antibodies. The enzymatic activity is measured in the presence and absence of the compound inhibitors to demonstrate specific inhibition of beta-secretase mediated cleavage of APP substrate.

20 **Example F**

Inhibition of Beta-Secretase in Animal Models of AD

Various animal models can be used to screen for 25 inhibition of beta-secretase activity. Examples of animal models useful in the invention include, but are not limited to, mouse, guinea pig, dog, and the like. The animals used can be wild type, transgenic, or knockout models. In addition, mammalian models can express mutations in APP, such as APP695-SW and the like described herein. Examples of transgenic non-human mammalian models are described in U.S. Patent Nos. 30 5,604,102, 5,912,410 and 5,811,633.

PDAPP mice, prepared as described in Games et al., 1995, *Nature* 373:523-527 are useful to analyze *in vivo* suppression of A beta release in the presence of putative inhibitory compounds. As described in U.S. Patent No. 6,191,166, 4 month

old PDAPP mice are administered compound formulated in vehicle, such as corn oil. The mice are dosed with compound (1-30 mg/ml; preferably 1-10 mg/ml). After time, e.g., 3-10 hours, the animals are sacrificed, and brains removed for 5 analysis.

Transgenic animals are administered an amount of the compound inhibitor formulated in a carrier suitable for the chosen mode of administration. Control animals are untreated, treated with vehicle, or treated with an inactive compound. 10 Administration can be acute, i.e., single dose or multiple doses in one day, or can be chronic, i.e., dosing is repeated daily for a period of days. Beginning at time 0, brain tissue or cerebral fluid is obtained from selected animals and analyzed for the presence of APP cleavage peptides, including 15 A beta, for example, by immunoassay using specific antibodies for A beta detection. At the end of the test period, animals are sacrificed and brain tissue or cerebral fluid is analyzed for the presence of A beta and/or beta-amyloid plaques. The tissue is also analyzed for necrosis.

20 Animals administered the compound inhibitors of the invention are expected to demonstrate reduced A beta in brain tissues or cerebral fluids and reduced beta amyloid plaques in brain tissue, as compared with non-treated controls.

25 **Example G**

Inhibition of A Beta Production in Human Patients

Patients suffering from Alzheimer's Disease (AD) demonstrate an increased amount of A beta in the brain. AD patients are administered an amount of the compound inhibitor 30 formulated in a carrier suitable for the chosen mode of administration. Administration is repeated daily for the duration of the test period. Beginning on day 0, cognitive and memory tests are performed, for example, once per month.

Patients administered the compound inhibitors are expected to demonstrate slowing or stabilization of disease progression as analyzed by changes in one or more of the following disease parameters: A beta present in CSF or 5 plasma; brain or hippocampal volume; A beta deposits in the brain; amyloid plaque in the brain; and scores for cognitive and memory function, as compared with control, non-treated patients.

Example H

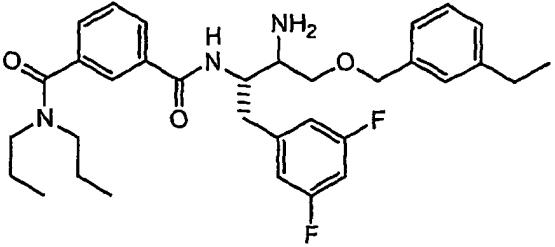
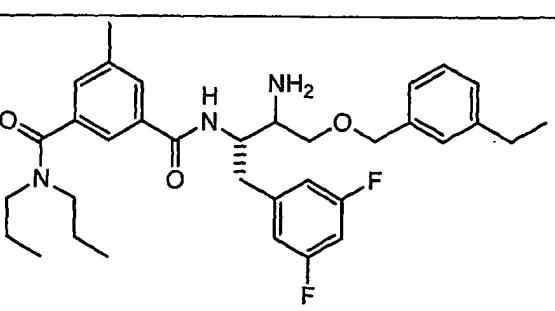
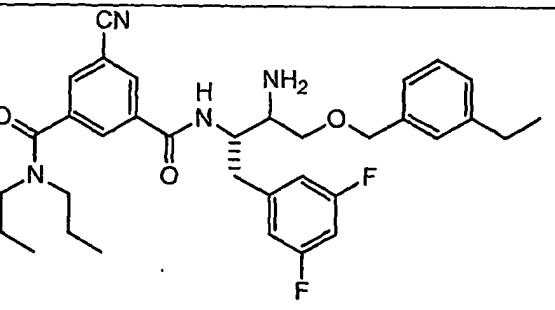
10 Prevention of A Beta Production in Patients at Risk for
AD

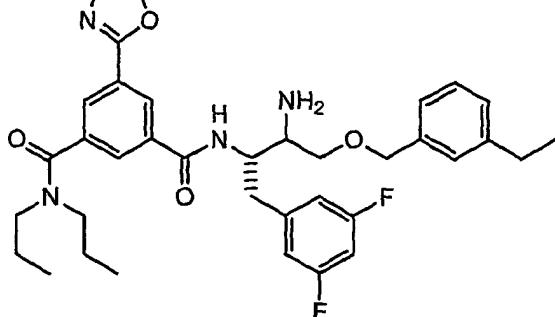
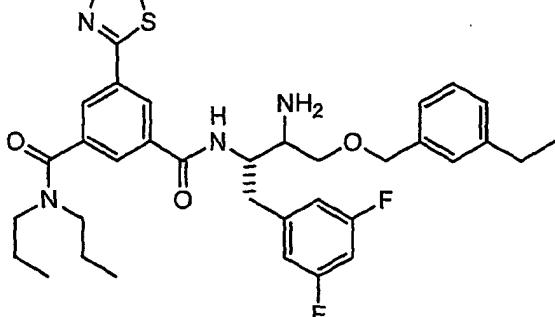
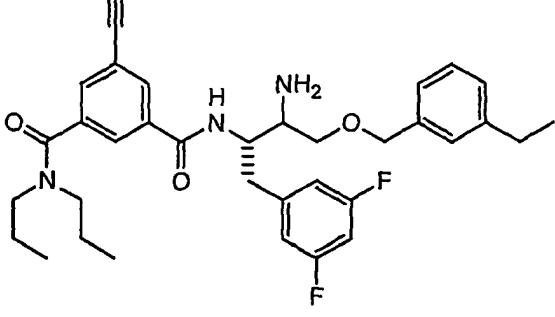
Patients predisposed or at risk for developing AD are identified either by recognition of a familial inheritance pattern, for example, presence of the Swedish Mutation, and/or 15 by monitoring diagnostic parameters. Patients identified as predisposed or at risk for developing AD are administered an amount of the compound inhibitor formulated in a carrier suitable for the chosen mode of administration. Administration is repeated daily for the duration of the test 20 period. Beginning on day 0, cognitive and memory tests are performed, for example, once per month.

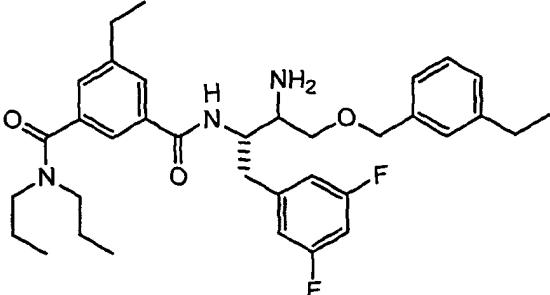
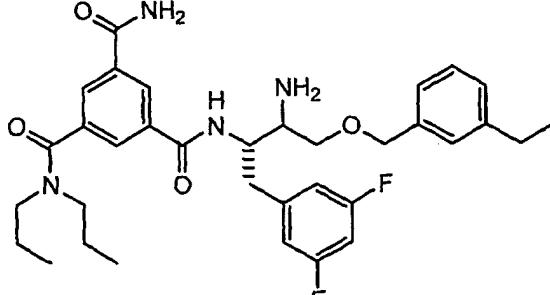
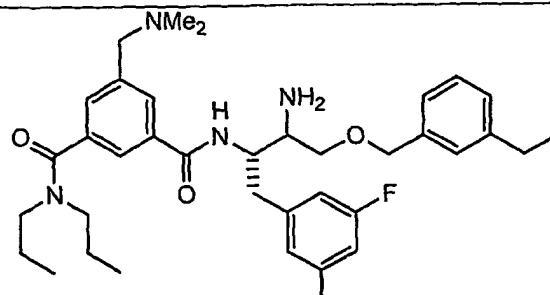
Patients administered the compound inhibitors are expected to demonstrate slowing or stabilization of disease progression as analyzed by changes in one or more of the 25 following disease parameters: A beta present in CSF or plasma; brain or hippocampal volume; amyloid plaque in the brain; and scores for cognitive and memory function, as compared with control, non-treated patients.

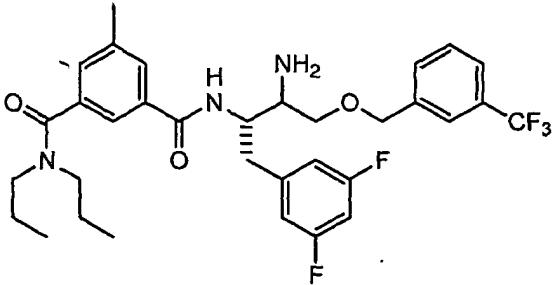
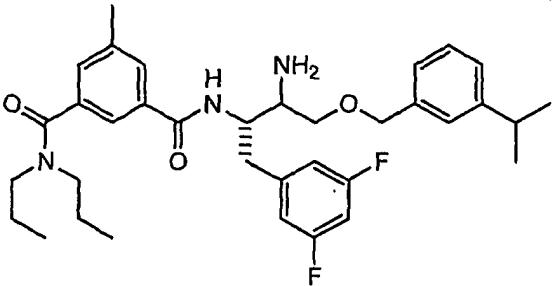
CHEMISTRY EXAMPLES

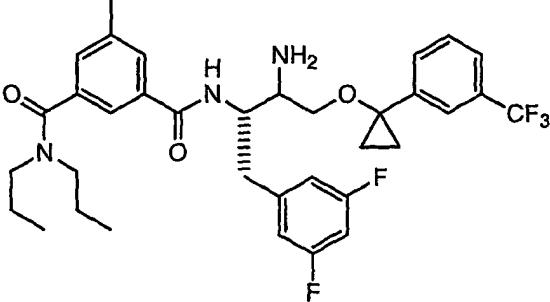
30 The following compounds are prepared essentially according to the procedures outlined above. All structures were named using Name Pro IUPAC Naming Software, version 6.00, available from Advanced Chemical Development, Inc., 90 Adelaide Street West, Toronto, Ontario, M5H 3V9, Canada.

Ex. No.	Structure/Name
1	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl)oxy]propyl } -N,N-dipropylisophthalamide</p>
2	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl)oxy]propyl } -5-methyl-<i>N,N</i>-dipropylisophthalamide</p>
3	<p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl)oxy]propyl } -5-bromo-<i>N,N</i>-dipropylisophthalamide</p>
4	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl)oxy]propyl } -5-cyano-<i>N,N</i>-dipropylisophthalamide</p>

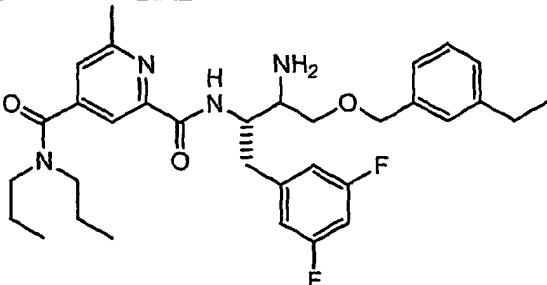
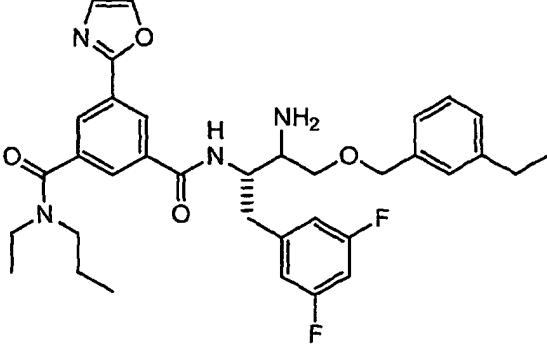
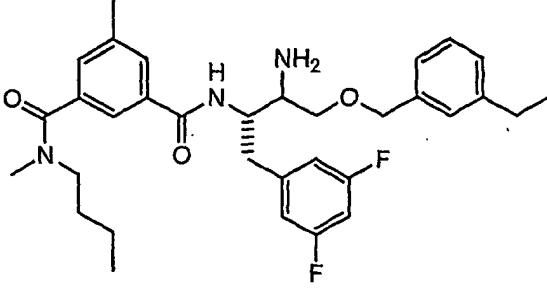
5	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl)oxy]propyl} -5- (1,3-oxazol-2-yl) -<i>N,N</i>-dipropylisophthalamide</p>
6	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl)oxy]propyl} -<i>N,N</i>-dipropyl-5- (1,3-thiazol-2-yl) isophthalamide</p>
7	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl)oxy]propyl} -5-ethynyl-<i>N,N</i>-dipropylisophthalamide</p>

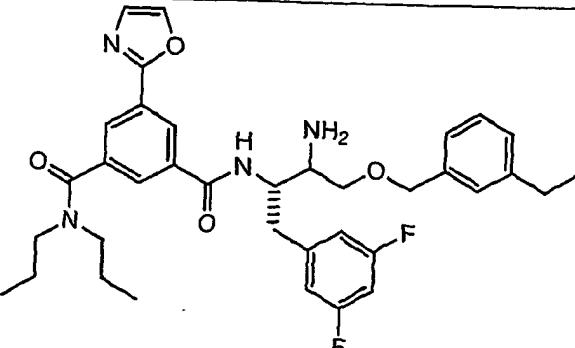
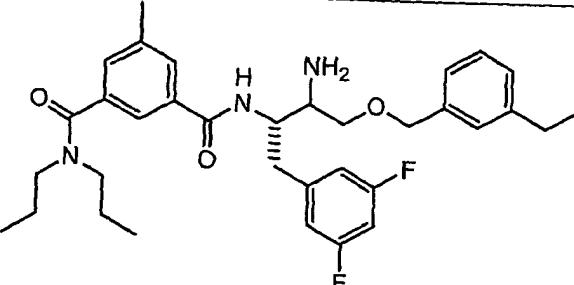
8	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl) oxy] propyl } -5-ethyl -<i>N,N</i>-dipropylisophthalamide</p>
9	 <p><i>N</i>³ - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl) oxy] propyl } -<i>N</i>¹,<i>N</i>¹-dipropylbenzene-1,3,5-tricarboxamide</p>
10	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-ethylbenzyl) oxy] propyl } -5- [(dimethylamino) methyl] -<i>N,N</i>-dipropylisophthalamide</p>
11	<i>N'</i> - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-

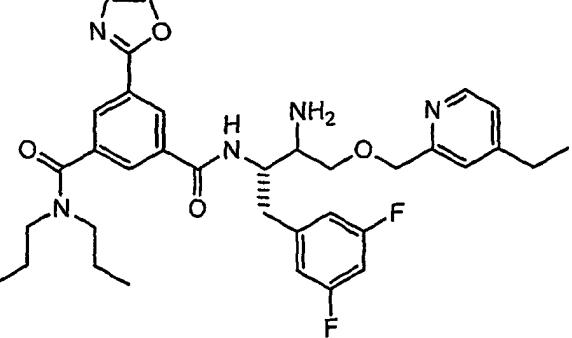
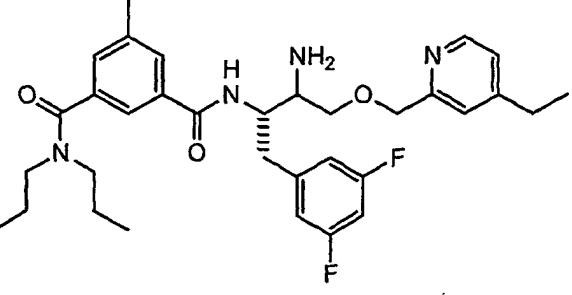
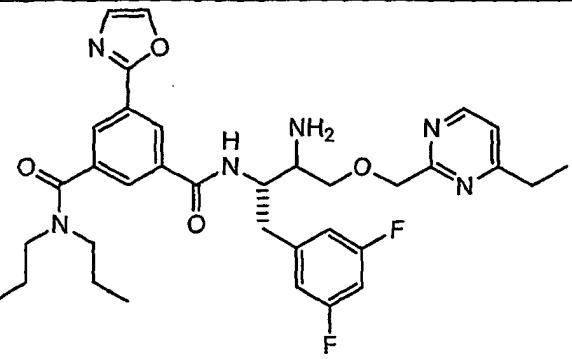
	ethynylbenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-N,N-dipropylisophthalamide
12	$N'-(1S)-2\text{-amino-1-}(3,5\text{-difluorobenzyl})-3-[(3\text{-ethynylbenzyl)oxy]propyl}-5\text{-methyl-}N,N\text{-dipropylisophthalamide}$
13	$N'-(1S)-2\text{-amino-1-}(3,5\text{-difluorobenzyl})-3-[[3\text{-}(trifluoromethyl)benzyl]oxy]propyl}-5-(1,3-oxazol-2-yl)-N,N\text{-dipropylisophthalamide}$
14	 <p>$N'-(1S)-2\text{-amino-1-}(3,5\text{-difluorobenzyl})-3-[[3\text{-}(trifluoromethyl)benzyl]oxy]propyl}-5\text{-methyl-}N,N\text{-dipropylisophthalamide}$</p>
15	$N'-(1S)-2\text{-amino-1-}(3,5\text{-difluorobenzyl})-3-[(3\text{-isopropylbenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-N,N\text{-dipropylisophthalamide}$
16	 <p>$N'-(1S)-2\text{-amino-1-}(3,5\text{-difluorobenzyl})-3-[(3\text{-isopropylbenzyl)oxy]propyl}-5\text{-methyl-}N,N\text{-dipropylisophthalamide}$</p>
17	$N'-(1S)-2\text{-amino-1-}(3,5\text{-difluorobenzyl})-3-[(3\text{-methoxybenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-N,N\text{-dipropylisophthalamide}$

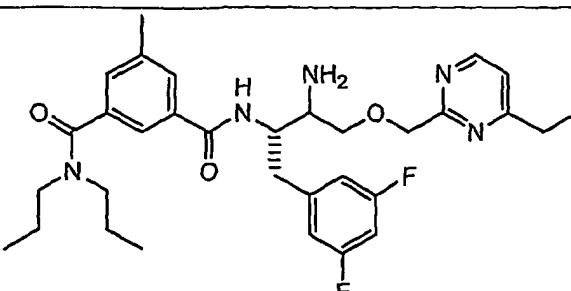
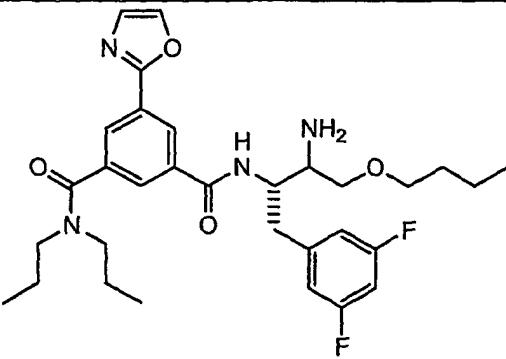
	dipropylisophthalamide
18	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(3-methoxybenzyl) oxy] propyl } -5-methyl- <i>N,N</i> -dipropylisophthalamide
19	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { [1- (3-ethynylphenyl) cyclopropyl] oxy } propyl } -5- (1,3-oxazol-2-yl) - <i>N,N</i> -dipropylisophthalamide
20	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { [1- (3-ethynylphenyl) cyclopropyl] oxy } propyl } -5-methyl- <i>N,N</i> -dipropylisophthalamide
21	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { {1- [3-(trifluoromethyl) phenyl] cyclopropyl} oxy } propyl } -5- (1,3-oxazol-2-yl) - <i>N,N</i> -dipropylisophthalamide
22	 <p>N' - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { {1- [3-(trifluoromethyl) phenyl] cyclopropyl} oxy } propyl } -5-methyl-<i>N,N</i>-dipropylisophthalamide</p>
23	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { [1- (3-isopropylphenyl) cyclopropyl] oxy } propyl } -5- (1,3-oxazol-2-yl) - <i>N,N</i> -dipropylisophthalamide
24	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { [1- (3-isopropylphenyl) cyclopropyl] oxy } propyl } -5-methyl- <i>N,N</i> -dipropylisophthalamide
25	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { [1- (3-methoxyphenyl) cyclopropyl] oxy } propyl } -5- (1,3-oxazol-2-yl) - <i>N,N</i> -dipropylisophthalamide
26	N' - { (1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- { [1- (3-

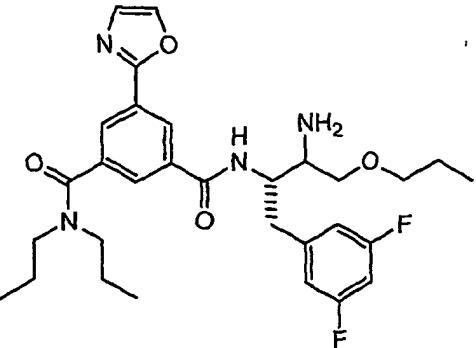
	<i>methoxyphenyl)cyclopropyl]oxy}propyl)-5-methyl-<i>N,N</i>-dipropylisophthalamide</i>
27	<i>N</i> ¹ -{(1 <i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-ethylphenyl)cyclopropyl]oxy}propyl)-5-(1,3-oxazol-2-yl)- <i>N,N</i> -dipropylisophthalamide
28	<i>N</i> ¹ -{(1 <i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-ethylphenyl)cyclopropyl]oxy}propyl)-5-methyl- <i>N,N</i> -dipropylisophthalamide
29	<i>N</i> ⁴ -{(1 <i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-(1,3-oxazol-2-yl)- <i>N</i> ² , <i>N</i> ² -dipropylpyridine-2,4-dicarboxamide
30	<p><i>N</i>⁴-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-methyl-<i>N</i>²,<i>N</i>²-dipropylpyridine-2,4-dicarboxamide</p>
31	<p><i>N</i>²-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-(1,3-oxazol-2-yl)-<i>N</i>⁴,<i>N</i>⁴-dipropylpyridine-2,4-dicarboxamide</p>

32	 <p><i>N</i>²-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-methyl-<i>N</i>⁴,<i>N</i>⁴-dipropylpyridine-2,4-dicarboxamide</p>
33	 <p><i>N</i>¹-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-<i>N</i>-ethyl-5-(1,3-oxazol-2-yl)-<i>N</i>-propylisophthalamide</p>
34	<p><i>N</i>¹-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-<i>N</i>-ethyl-5-methyl-<i>N</i>-propylisophthalamide</p>
35	<p><i>N</i>¹-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-<i>N</i>-butyl-<i>N</i>-methyl-5-(1,3-oxazol-2-yl)isophthalamide</p>
36	

	<p><i>N'</i>-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-<i>N</i>-butyl-<i>N</i>,5-dimethylisophthalamide</p>
37	 <p><i>N'</i>-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-<i>N,N</i>-dipropylisophthalamide</p>
38	 <p><i>N'</i>-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-methyl-<i>N,N</i>-dipropylisophthalamide</p>
39	<p><i>N'</i>-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(6-ethylpyridin-2-yl)methoxy]propyl}-5-(1,3-oxazol-2-yl)-<i>N,N</i>-dipropylisophthalamide</p>
40	<p><i>N'</i>-{(1<i>S</i>)-2-amino-1-(3,5-difluorobenzyl)-3-[(6-ethylpyridin-2-yl)methoxy]propyl}-5-methyl-<i>N,N</i>-dipropylisophthalamide</p>

41	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(4-ethylpyridin-2-yl)methoxy]propyl } -5- (1,3-oxazol-2-yl) -<i>N,N</i>-dipropylisophthalamide</p>
42	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(4-ethylpyridin-2-yl)methoxy]propyl } -5-methyl-<i>N,N</i>-dipropylisophthalamide</p>
43	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(4-ethylpyrimidin-2-yl)methoxy]propyl } -5- (1,3-oxazol-2-yl) -<i>N,N</i>-dipropylisophthalamide</p>

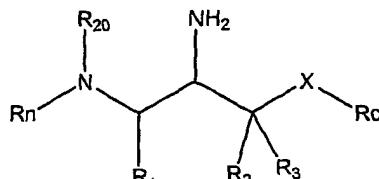
44	 <p><i>N'</i> - { (1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- [(4-ethylpyrimidin-2-yl)methoxy]propyl } -5-methyl-<i>N,N</i>-dipropylisophthalamide</p>
45	 <p><i>N'</i> - [(1<i>S</i>) -2-amino-3-butoxy-1- (3,5-difluorobenzyl)propyl] -5- (1,3-oxazol-2-yl) -<i>N,N</i>-dipropylisophthalamide</p>
46	<p><i>N'</i> - [(1<i>S</i>) -2-amino-3-butoxy-1- (3,5-difluorobenzyl)propyl] -5-methyl-<i>N,N</i>-dipropylisophthalamide</p>
47	<p><i>N'</i> - [(1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- (3-methylbutoxy)propyl] -5- (1,3-oxazol-2-yl) -<i>N,N</i>-dipropylisophthalamide</p>
48	<p><i>N'</i> - [(1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- (3-methylbutoxy)propyl] -5-methyl-<i>N,N</i>-dipropylisophthalamide</p>

49	 <p><i>N'</i> - [(1<i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- propoxypropyl] -5- (1,3-oxazol-2-yl) -<i>N,N</i>- dipropylisophthalamide</p>
50	<i>N'</i> - [(1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- propoxypropyl] -5-methyl- <i>N,N</i> -dipropylisophthalamide
51	<i>N'</i> - [(1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- isobutoxypropyl] -5- (1,3-oxazol-2-yl) - <i>N,N</i> - dipropylisophthalamide
52	<i>N'</i> - [(1 <i>S</i>) -2-amino-1- (3,5-difluorobenzyl) -3- isobutoxypropyl] -5-methyl- <i>N,N</i> -dipropylisophthalamide

The invention has been described with reference to various specific and preferred embodiments and techniques. However, it should be understood that many variations and 5 modifications may be made while remaining within the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A compound of the formula:



or a pharmaceutically acceptable salt or ester thereof;
 wherein X is O, S, NR₂₀, or NR₂₀NR₂₀;
 wherein each R₂₀ is H, C₁₋₆ alkyl or alkenyl, C₁₋₆ haloalkyl or
 10 C₄₋₇ cycloalkyl;
 wherein R₁ is -(CH₂)₁₋₂-S(O)₀₋₂-(C_{1-C₆} alkyl), or
 C_{1-C₁₀} alkyl optionally substituted with 1, 2, or 3 groups
 independently selected from halogen, -OH, =O, -SH,
 -C≡N, -CF₃, -C_{1-C₃} alkoxy, amino, mono- or
 15 dialkylamino, -N(R)C(O)R'-, -OC(=O)-amino and -
 OC(=O)-mono- or dialkylamino, or
 C_{2-C₆} alkenyl or C_{2-C₆} alkynyl, each of which is optionally
 substituted with 1, 2, or 3 groups independently
 selected from halogen, -OH, -SH, -C≡N, -CF₃, C_{1-C₃}
 20 alkoxy, amino, and mono- or dialkylamino, or
 aryl, heteroaryl, heterocyclyl, -C_{1-C₆} alkyl-aryl, -C_{1-C₆}
 alkyl-heteroaryl, or -C_{1-C₆} alkyl-heterocyclyl, where
 the ring portions of each are optionally substituted
 with 1, 2, 3, or 4 groups independently selected
 25 from halogen, -OH, -SH, -C≡N, -NR₁₀₅R'₁₀₅, -CO₂R, -
 N(R)COR', or -N(R)SO₂R', -C(=O)-(C_{1-C₄}) alkyl, -SO₂-
 amino, -SO₂-mono or dialkylamino, -C(=O)-amino,
 -C(=O)-mono or dialkylamino, -SO₂-(C_{1-C₄}) alkyl, or
 C_{1-C₆} alkoxy optionally substituted with 1, 2, or 3
 30 groups which are independently selected from
 halogen, or

C₃-C₇ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, -C₁-C₆ alkyl and mono- or dialkylamino, or

5 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, -C₁-C₃ alkoxy, amino, mono- or dialkylamino and -C₁-C₃ alkyl, or

10 C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl each of which is optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, C₁-C₆ alkyl and mono- or dialkylamino; and the heterocyclyl group is optionally further substituted with

15 oxo;

R and R' independently are hydrogen, C₁-C₁₀ alkyl, C₁-C₁₀ alkylaryl or C₁-C₁₀ alkylheteroaryl;

wherein R_c is hydrogen, -(CR₂₄₅R₂₅₀)₀₋₄-aryl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl, -(CR₂₄₅R₂₅₀)₀₋₄-aryl-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl-aryl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl-aryls, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl-heterocyclyl, -(CR₂₄₅R₂₅₀)₀₋₄-heteroaryl-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl-heteroaryl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl-heterocyclyl, -(CR₂₄₅R₂₅₀)₀₋₄-heterocyclyl-aryl, -[C(R₂₅₅)(R₂₆₀)]₁₋₃-CO-N-(R₂₅₅)₂, -CH(aryl)₂, -CH(heteroaryl)₂, -CH(heterocyclyl)₂, -CH(aryl)(heteroaryl), -(CH₂)₀₋₁-CH((CH₂)₀₋₆-OH)-(CH₂)₀₋₁-aryl, -(CH₂)₀₋₁-CH((CH₂)₀₋₆-OH)-(CH₂)₀₋₁-heteroaryl, -CH(-aryl or -heteroaryl)-CO-O(C₁-C₄ alkyl), -CH(-CH₂-OH)-CH(OH)-phenyl-NO₂, (C₁-C₆ alkyl)-O-(C₁-C₆ alkyl)-OH, -CH₂-NH-CH₂-CH(-O-CH₂-CH₃)₂, -(CH₂)₀₋₆-C(=NR₂₃₅)(NR₂₃₅R₂₄₀), or

25 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of

100- (C₁-C₆ alkyl optionally substituted with 1, 2, 3, or 5 - F), C₃-C₇ cycloalkyl, -(CH₂)₀₋₄-N(H or R₂₁₅)-SO₂-R₂₂₀, -(CH₂)₀₋₄-C₃-C₇ cycloalkyl, or

5 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 R₂₀₅ groups, or

C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl, each of which is optionally substituted with 1 or 2 R₂₀₅ groups, wherein

10 the aryl and heteroaryl groups at each occurrence are optionally substituted with 1, 2, or 3 groups that are independently R₂₀₅, R₂₁₀, or

15 C₁-C₆ alkyl substituted with 1, 2, or 3 groups that are independently R₂₀₅ or R₂₁₀, and wherein

the heterocyclyl group at each occurrence is optionally substituted with 1, 2, or 3 groups that are independently R₂₁₀;

20 R₂₀₅ at each occurrence is independently selected from C₁-C₆ alkyl, halogen, -OH, -O-phenyl, -SH, -C≡N, -CF₃, C₁-C₆ alkoxy, NH₂, NH(C₁-C₆ alkyl) or N-(C₁-C₆ alkyl)(C₁-C₆ alkyl);

25 R₂₁₀ at each occurrence is independently selected from halogen, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, -NR₂₂₀R₂₂₅, OH, C≡N, -CO-(C₁-C₄ alkyl), -SO₂-NR₂₃₅R₂₄₀, -CO-NR₂₃₅R₂₄₀, -SO₂-(C₁-C₄ alkyl), =O, or

30 C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl or C₃-C₇ cycloalkyl, each of which is optionally substituted with 1, 2, or 3 R₂₀₅ groups;

R₂₁₅ at each occurrence is independently selected from C₁-C₆ alkyl, -(CH₂)₀₋₂-(aryl), C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₇ cycloalkyl, and -(CH₂)₀₋₂-(heteroaryl), -(CH₂)₀₋₂-(heterocyclyl), wherein

the aryl group at each occurrence is optionally substituted with 1, 2, or 3 groups that are independently R₂₀₅ or R₂₁₀, and wherein

the heterocyclyl and heteroaryl groups at each occurrence are optionally substituted with 1, 2, or 3 R_{210} ;

10 R_{220} and R_{225} at each occurrence are independently selected from -H, -C₁-C₇ cycloalkyl, -(C₁-C₂ alkyl)-(C₃-C₇ cycloalkyl), -(C₁-C₆ alkyl)-O-(C₁-C₃ alkyl), -C₂-C₆ alkenyl, -C₂-C₆ alkynyl, -C₁-C₆ alkyl chain with one double bond and one triple bond, -aryl, -heteroaryl, and -heterocyclyl, or -C₁-C₁₀ alkyl optionally substituted with -OH, -NH₂ or halogen, wherein

15 the aryl, heterocyclyl and heteroaryl groups at each occurrence are optionally substituted with 1, 2, or 3 R_{270} groups

20 R_{235} and R_{240} at each occurrence are independently H, or C₁-C₆ alkyl;

25 R_{245} and R_{250} at each occurrence are independently selected from -H, C₁-C₄ alkyl, C₁-C₄ alkylaryl, C₁-C₄ alkylheteroaryl, C₁-C₄ hydroxyalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, -(CH₂)₀₋₄-C₃-C₇ cycloalkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, and phenyl; or

30 R_{245} and R_{250} are taken together with the carbon to which they are attached to form a carbocycle of 3, 4, 5, 6, or 7 carbon atoms, where one carbon atom is optionally replaced by a heteroatom selected from -O-, -S-, -SO₂-, and -NR₂₂₀-;

35 R_{255} and R_{260} at each occurrence are independently selected from -H, -(CH₂)₁₋₂-S(O)₀₋₂-(C₁-C₆ alkyl), -(C₁-C₄ alkyl)-aryl, -(C₁-C₄ alkyl)-heteroaryl, -(C₁-C₄ alkyl)-heterocyclyl, -aryl, -heteroaryl, -heterocyclyl, -(CH₂)₁₋₄-R₂₆₅-(CH₂)₀₋₄-aryl, -(CH₂)₁₋₄-R₂₆₅-(CH₂)₀₋₄-heteroaryl, -(CH₂)₁₋₄-R₂₆₅-(CH₂)₀₋₄-heterocyclyl, or

40 C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl or -(CH₂)₀₋₄-C₃-C₇ cycloalkyl, each of which is optionally substituted with 1, 2, or 3 R_{205} groups, wherein

each aryl or phenyl is optionally substituted with 1, 2, or 3 groups that are independently R_{205} , R_{210} , or C_1-C_6 alkyl substituted with 1, 2, or 3 groups that are independently R_{205} or R_{210} , and wherein

5 each heterocyclyl is optionally substituted with 1, 2, 3, or 4 R_{210} ;

R_{265} at each occurrence is independently $-O-$, $-S-$ or $-N(C_1-C_6$ alkyl)-;

10 R_{270} at each occurrence is independently R_{205} , halogen C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, $NR_{235}R_{240}$, $-OH$, $-C\equiv N$, $-CO-(C_1-C_4$ alkyl), $-SO_2-NR_{235}R_{240}$, $-CO-NR_{235}R_{240}$, $-SO_2-(C_1-C_4$ alkyl), $=O$, or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl or $-(CH_2)_{0-4}-C_3-C_7$ cycloalkyl, each of which is optionally substituted with 1, 2, or 3 R_{205} groups;

15 wherein R_n is R'_{100} , $-SO_2R'_{100}$, $-(CRR')_{1-6}R'_{100}$, $-C(=O)-(CRR')_{0-6}R_{100}$, $-C(=O)-(CRR')_{1-6}-O-R'_{100}$, $-C(=O)-(CRR')_{1-6}-S-R'_{100}$, $-C(=O)-(CRR')_{1-6}-C(=O)-R_{100}$, $-C(=O)-(CRR')_{1-6}-SO_2-R_{100}$; $-C(=O)-(CRR')_{1-6}-NR_{100}-R'_{100}$; or $\begin{array}{c} Y-Z-X-(CH_2)_{n7}-CHC(O)- \\ | \\ R_4 \end{array}$;

20 R_4 is selected from the group consisting of H; NH_2 ; $-NH-(CH_2)_{n6}-R_{4-1}$; $-NHR_8$; $-NR_{50}C(O)R_5$; C_1-C_4 alkyl- $NHC(O)R_5$; $-(CH_2)_{0-4}R_8$; $-O-C_1-C_4$ alkanoyl; OH; C_6-C_{10} aryloxy optionally substituted with 1, 2, or 3 groups that are independently halogen, C_1-C_4 alkyl, $-CO_2H$, $-C(O)-C_1-C_4$ alkoxy, or C_1-C_4 alkoxy; C_1-C_6 alkoxy; aryl C_1-C_4 alkoxy; $-NR_{50}CO_2R_{51}$; $-C_1-C_4$ alkyl- $NR_{50}CO_2R_{51}$; $-C\equiv N$; $-CF_3$; $-CF_2-CF_3$; $-C\equiv CH$; $-CH_2-CH=CH_2$; $-(CH_2)_{1-4}-R_{4-1}$; $-(CH_2)_{1-4}-NH-R_{4-1}$; $-O-(CH_2)_{n6}-R_{4-1}$; $-S-(CH_2)_{n6}-R_{4-1}$; $-(CH_2)_{0-4}-NHC(O)-(CH_2)_{0-6}-R_{52}$; $-(CH_2)_{0-4}-R_{53}-(CH_2)_{0-4}-R_{54}$;

25 wherein

30 n_6 is 0, 1, 2, or 3;

n_7 is 0, 1, 2, or 3;

R_{4-1} is selected from the group consisting of $-SO_2-(C_1-C_8$ alkyl), $-SO-(C_1-C_8$ alkyl), $-S-(C_1-C_8$ alkyl), $-S-CO-$

(C₁-C₆ alkyl), -SO₂-NR₄₋₂R₄₋₃; -CO-C₁-C₂ alkyl; -CO-NR₄₋₃R₄₋₄;
R₄₋₂ and R₄₋₃ are independently H, C₁-C₃ alkyl, or C₃-C₆ cycloalkyl;
5 R₄₋₄ is alkyl, arylalkyl, alkanoyl, or arylalkanoyl;
R₄₋₆ is H or C₁-C₆ alkyl;
R₅ is selected from the group consisting of C₃-C₇ cycloalkyl; C₁-C₆ alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen,
10 -NR₆R₇, C₁-C₄ alkoxy, C₅-C₆ heterocycloalkyl, C₅-C₆ heteroaryl, C₆-C₁₀ aryl, C₃-C₇ cycloalkyl C₁-C₄ alkyl, -S-C₁-C₄ alkyl, -SO₂-C₁-C₄ alkyl, -CO₂H, -CONR₆R₇, -CO₂-C₁-C₄ alkyl, C₆-C₁₀ aryloxy; heteroaryl optionally substituted with 1, 2, or 3 groups that are
15 independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, C₁-C₄ haloalkyl, or OH; heterocycloalkyl optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, or C₂-C₄ alkanoyl; aryl optionally substituted with 1, 2, 3, or 4 groups that are independently halogen, OH, C₁-C₄ alkyl, C₁-C₄ alkoxy, or C₁-C₄ haloalkyl; and
20 -NR₆R₇; wherein
R₆ and R₇ are independently selected from the group consisting of H, C₁-C₆ alkyl, C₂-C₆ alkanoyl, phenyl, -SO₂-C₁-C₄ alkyl, phenyl C₁-C₄ alkyl;
25 R₈ is selected from the group consisting of -SO₂-heteroaryl, -SO₂-aryl, -SO₂-heterocycloalkyl, -SO₂-C₁-C₁₀ alkyl, -C(O)NHR₉, heterocycloalkyl, -S-C₁-C₆ alkyl, -S-C₂-C₄ alkanoyl, wherein
30 R₉ is aryl C₁-C₄ alkyl, C₁-C₆ alkyl, or H;
R₅₀ is H or C₁-C₆ alkyl;
R₅₁ is selected from the group consisting of aryl C₁-C₄ alkyl; C₁-C₆ alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen, cyano,

heteroaryl, -NR₆R₇, -C(O)NR₆R₇, C₃-C₇ cycloalkyl, or -C₁-C₄ alkoxy; heterocycloalkyl optionally substituted with 1 or 2 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, C₂-C₄ alkanoyl, aryl C₁-C₄ alkyl, and -SO₂ C₁-C₄ alkyl; alkenyl; alkynyl; heteroaryl optionally substituted with 1, 2, or 3 groups that are independently OH, C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, NH₂, NH(C₁-C₆ alkyl) or N(C₁-C₆ alkyl)(C₁-C₆ alkyl); heteroarylalkyl 5 optionally substituted with 1, 2, or 3 groups that are independently C₁-C₄ alkyl, C₁-C₄ alkoxy, halogen, NH₂, NH(C₁-C₆ alkyl) or N(C₁-C₆ alkyl)(C₁-C₆ alkyl); aryl; heterocycloalkyl; C₃-C₈ cycloalkyl; and cycloalkylalkyl; wherein the aryl; heterocycloalkyl, 10 C₃-C₈ cycloalkyl, and cycloalkylalkyl groups are optionally substituted with 1, 2, 3, 4 or 5 groups that are independently halogen, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₂-C₆ alkanoyl, C₁-C₆ haloalkyl, C₁-C₆ haloalkoxy, hydroxy, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, 15 C₁-C₆ alkyl, C₁-C₆ thioalkoxy, C₁-C₆ thioalkoxy C₁-C₆ alkyl, or C₁-C₆ alkoxy C₁-C₆ alkoxy; 20 R₅₂ is heterocycloalkyl, heteroaryl, aryl, cycloalkyl, -S(O)₀₋₂-C₁-C₆ alkyl, CO₂H, -C(O)NH₂, -C(O)NH(alkyl), -C(O)N(alkyl)(alkyl), -CO₂-alkyl, -NHS(O)₀₋₂-C₁-C₆ alkyl, 25 -N(alkyl)S(O)₀₋₂-C₁-C₆ alkyl, -S(O)₀₋₂-heteroaryl, -S(O)₀₋₂-aryl, -NH(arylalkyl), -N(alkyl)(arylalkyl), thioalkoxy, or alkoxy, each of which is optionally substituted with 1, 2, 3, 4, or 5 groups that are independently alkyl, alkoxy, 30 thioalkoxy, halogen, haloalkyl, haloalkoxy, alkanoyl, NO₂, CN, alkoxycarbonyl, or aminocarbonyl; R₅₃ is absent, -O-, -C(O)-, -NH-, -N(alkyl)-, -NH-S(O)₀₋₂-, -N(alkyl)-S(O)₀₋₂-, -S(O)₀₋₂-NH-, -S(O)₀₋₂-N(alkyl)-, -NH-C(S)-, or -N(alkyl)-C(S)-;

R₅₄ is heteroaryl, aryl, arylalkyl, heterocycloalkyl, CO₂H, -CO₂-alkyl, -C(O)NH(alkyl), -C(O)N(alkyl) (alkyl), -C(O)NH₂, C₁-C₈ alkyl, OH, aryloxy, alkoxy, arylalkoxy, NH₂, NH(alkyl), N(alkyl) (alkyl), or -C₁-C₆ alkyl-CO₂-C₁-C₆ alkyl, each of which is optionally substituted with 1, 2, 3, 4, or 5 groups that are independently alkyl, alkoxy, CO₂H, -CO₂-alkyl, thioalkoxy, halogen, haloalkyl, haloalkoxy, hydroxyalkyl, alkanoyl, NO₂, CN, alkoxycarbonyl, or aminocarbonyl;

X' is selected from the group consisting of -C₁-C₆ alkylidenyl optionally optionally substituted with 1, 2, or 3 methyl groups; and -NR₄₋₆-; or

R₄ and R₄₋₆ combine to form -(CH₂)_{n10}-, wherein

n₁₀ is 1, 2, 3, or 4;

Z is selected from the group consisting of a bond; SO₂; SO; S; and C(O);

Y is selected from the group consisting of H; C₁-C₄ haloalkyl; C₅-C₆ heterocycloalkyl; C₆-C₁₀ aryl; OH; -N(Y₁)(Y₂); C₁-C₁₀ alkyl optionally substituted with 1 thru 3 substituents which can be the same or different and are selected from the group consisting of halogen, hydroxy, alkoxy, thioalkoxy, and haloalkoxy; C₃-C₈ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₃ alkyl, and halogen; alkoxy; aryl optionally substituted with halogen, alkyl, alkoxy, CN or NO₂; arylalkyl optionally substituted with halogen, alkyl, alkoxy, CN or NO₂; wherein

Y₁ and Y₂ are the same or different and are H; C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 substituents selected from the group consisting of halogen, C₁-C₄ alkoxy, C₃-C₈ cycloalkyl, and OH; C₂-C₆ alkenyl; C₂-C₆ alkanoyl; phenyl; -SO₂-C₁-C₄ alkyl; phenyl C₁-C₄ alkyl; or C₃-C₈ cycloalkyl C₁-C₄ alkyl; or

Y_1 , Y_2 and the nitrogen to which they are attached form a ring selected from the group consisting of piperazinyl, piperidinyl, morpholinyl, and pyrrolidinyl, wherein each ring is optionally substituted with 1, 2, 3, or 4 groups that are independently C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_1 - C_6 alkoxy C_1 - C_6 alkyl, or halogen;

R_{100} and R'_{100} independently represent aryl, heteroaryl, -aryl-W-aryl, -aryl-W-heteroaryl, -aryl-W-heterocyclyl, -heteroaryl-W-aryl, -heteroaryl-W-heteroaryl, -heteroaryl-W-heterocyclyl, -heterocyclyl-W-heteroaryl, -heterocyclyl-W-heterocyclyl, - $CH[(CH_2)_{0-2}-O-R_{150}]- (CH_2)_{0-2}-aryl$, - $CH[(CH_2)_{0-2}-O-R_{150}]- (CH_2)_{0-2}-heterocyclyl$ or - $CH[(CH_2)_{0-2}-O-R_{150}]- (CH_2)_{0-2}-heteroaryl$, where the ring portions of each are optionally substituted with 1, 2, or 3 groups independently selected from

-OR, - NO_2 , halogen, - $C\equiv N$, - OCF_3 , - CF_3 , - $(CH_2)_{0-4}-O-P(=O)(OR)(OR')$, - $(CH_2)_{0-4}-CO-NR_{105}R'_{105}$, - $(CH_2)_{0-4}-O-(CH_2)_{0-4}-CONR_{102}R_{102}'$, - $(CH_2)_{0-4}-CO-(C_1-C_{12} \text{ alkyl})$, - $(CH_2)_{0-4}-CO-(C_2-C_{12} \text{ alkenyl})$, - $(CH_2)_{0-4}-CO-(C_2-C_{12} \text{ alkynyl})$, - $(CH_2)_{0-4}-CO-(CH_2)_{0-4}(C_3-C_7 \text{ cycloalkyl})$, - $(CH_2)_{0-4}-R_{110}$, - $(CH_2)_{0-4}-R_{120}$, - $(CH_2)_{0-4}-R_{130}$, - $(CH_2)_{0-4}-CO-R_{110}$, - $(CH_2)_{0-4}-CO-R_{120}$, - $(CH_2)_{0-4}-CO-R_{130}$, - $(CH_2)_{0-4}-CO-R_{140}$, - $(CH_2)_{0-4}-CO-O-R_{150}$, - $(CH_2)_{0-4}-SO_2-NR_{105}R'_{105}$, - $(CH_2)_{0-4}-SO-(C_1-C_8 \text{ alkyl})$, - $(CH_2)_{0-4}-SO_2-(C_1-C_{12} \text{ alkyl})$, - $(CH_2)_{0-4}-SO_2-(CH_2)_{0-4}(C_3-C_7 \text{ cycloalkyl})$, - $(CH_2)_{0-4}-N(R_{150})-CO-O-R_{150}$, - $(CH_2)_{0-4}-N(R_{150})-CO-N(R_{150})_2$, - $(CH_2)_{0-4}-N(R_{150})-CS-N(R_{150})_2$, - $(CH_2)_{0-4}-N(R_{150})-CO-R_{105}$, - $(CH_2)_{0-4}-NR_{105}R'_{105}$, - $(CH_2)_{0-4}-R_{140}$, - $(CH_2)_{0-4}-O-CO-(C_1-C_6 \text{ alkyl})$, - $(CH_2)_{0-4}-O-P(O)-(O-R_{110})_2$, - $(CH_2)_{0-4}-O-CO-N(R_{150})_2$, - $(CH_2)_{0-4}-O-CS-N(R_{150})_2$, - $(CH_2)_{0-4}-O-(R_{150})$, - $(CH_2)_{0-4}-O-R_{150}'-COOH$, - $(CH_2)_{0-4}-S-(R_{150})$, - $(CH_2)_{0-4}-N(R_{150})-SO_2-R_{105}$, - $(CH_2)_{0-4}-C_3-C_7 \text{ cycloalkyl}$, $(C_2-C_{10}) \text{ alkenyl}$, or $(C_2-C_{10}) \text{ alkynyl}$, or

R_{100} is C_1 - C_{10} alkyl optionally substituted with 1, 2, or 3 R_{115} groups, or

R_{100} is $-(C_1$ - C_6 alkyl)- O - C_1 - C_6 alkyl) or $-(C_1$ - C_6 alkyl)- S - $(C_1$ - C_6 alkyl), each of which is optionally substituted with 1, 2, or 3 R_{115} groups, or

5 R_{100} is C_3 - C_8 cycloalkyl optionally substituted with 1, 2, or 3 R_{115} groups;

W is $-(CH_2)_{0-4}-$, $-O-$, $-S(O)_{0-2}-$, $-N(R_{135})-$, $-CR(OH)-$ or $-C(O)-$;

R_{102} and R_{102}' independently are hydrogen, or

10 C_1 - C_{10} alkyl optionally substituted with 1, 2, or 3 groups that are independently halogen, aryl or $-R_{110}$;

R_{105} and R'_{105} independently represent $-H$, $-R_{110}$, $-R_{120}$, C_3 - C_7 cycloalkyl, $-(C_1$ - C_2 alkyl)- $(C_3$ - C_7 cycloalkyl), $-(C_1$ - C_6 alkyl)- O - $(C_1$ - C_3 alkyl), C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, or C_1 - C_6 alkyl chain with one double bond and one triple bond,

15 or

C_1 - C_6 alkyl optionally substituted with $-OH$ or $-NH_2$; or,

C_1 - C_6 alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, or

20 R_{105} and R'_{105} together with the atom to which they are attached form a 3 to 7 membered carbocyclic ring, where one member is optionally a heteratom selected from $-O-$, $-S(O)_{0-2}-$, $-N(R_{135})-$, the ring being optionally substituted with 1, 2 or three R_{140} groups;

25 R_{115} at each occurrence is independently halogen, $-OH$, $-CO_2R_{102}$, $-C_1$ - C_6 thioalkoxy, $-CO_2$ -phenyl, $-NR_{105}R'_{135}$, $-SO_2-(C_1$ - C_8 alkyl), $-C(=O)R_{180}$, R_{180} , $-CONR_{105}R'_{105}$, $-SO_2NR_{105}R'_{105}$, $-NH-CO-(C_1$ - C_6 alkyl), $-NH-C(=O)-OH$, $-NH-C(=O)-OR$, $-NH-C(=O)-O$ -phenyl, $-O-C(=O)-(C_1$ - C_6 alkyl), $-O-C(=O)$ -amino, $-O-C(=O)-$ mono- or dialkylamino, $-O-C(=O)$ -phenyl, $-O-(C_1$ - C_6 alkyl)- CO_2H , $-NH-SO_2-(C_1$ - C_6 alkyl), C_1 - C_6 alkoxy or C_1 - C_6 haloalkoxy;

30

R₁₃₅ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₇ cycloalkyl, -(CH₂)₀₋₂₋(aryl), -(CH₂)₀₋₂₋(heteroaryl), or -(CH₂)₀₋₂₋(heterocyclyl);

R₁₄₀ is heterocyclyl optionally substituted with 1, 2, 3, or 4 groups independently selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, halogen, hydroxy, cyano, nitro, amino, mono(C₁-C₆)alkylamino, di(C₁-C₆)alkylamino, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₁-C₆ haloalkoxy, amino(C₁-C₆)alkyl, mono(C₁-C₆)alkylamino(C₁-C₆)alkyl, di(C₁-C₆)alkylamino(C₁-C₆)alkyl, and =O;

R₁₅₀ is hydrogen, C₃-C₇ cycloalkyl, -(C₁-C₂ alkyl)-(C₃-C₇ cycloalkyl), C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ alkyl with one double bond and one triple bond, -R₁₁₀, -R₁₂₀, or C₁-C₆ alkyl optionally substituted with 1, 2, 3, or 4 groups independently selected from -OH, -NH₂, C₁-C₃ alkoxy, R₁₁₀, and halogen;

R_{150'} is C₃-C₇ cycloalkyl, -(C₁-C₃ alkyl)-(C₃-C₇ cycloalkyl), C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ alkyl with one double bond and one triple bond, -R₁₁₀, -R₁₂₀, or C₁-C₆ alkyl optionally substituted with 1, 2, 3, or 4 groups independently selected from -OH, -NH₂, C₁-C₃ alkoxy, R₁₁₀, and halogen;

R₁₆₀ is selected from morpholinyl, thiomorpholinyl, piperazinyl, piperidinyl, homomorpholinyl, homothiomorpholinyl, homothiomorpholinyl S-oxide, homothiomorpholinyl S,S-dioxide, pyrrolinyl and pyrrolidinyl, each of which is optionally substituted with 1, 2, 3, or 4 groups independently selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, halogen, hydroxy, cyano, nitro, amino, mono(C₁-C₆)alkylamino, di(C₁-C₆)alkylamino, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₁-C₆ haloalkoxy, amino(C₁-C₆)alkyl, mono(C₁-C₆)alkylamino(C₁-C₆)alkyl, di(C₁-C₆)alkylamino(C₁-C₆)alkyl, and =O;

R₁₁₀ is aryl optionally substituted with 1 or 2 R₁₂₅ groups;

R_{125} at each occurrence is independently halogen, amino, mono- or dialkylamino, -OH, -C≡N, -SO₂-NH₂, -SO₂-NH-C₁-C₆ alkyl, -SO₂-N(C₁-C₆ alkyl)₂, -SO₂-(C₁-C₄ alkyl), -CO-NH₂, -CO-NH-C₁-C₆ alkyl, or -CO-N(C₁-C₆ alkyl)₂, or

5 C₁-C₆ alkyl, C₂-C₆ alkenyl or C₂-C₆ alkynyl, each of which is optionally substituted with 1, 2, or 3 groups that are independently selected from C₁-C₃ alkyl, halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, and mono- and dialkylamino, or

10 C₁-C₆ alkoxy optionally substituted with one, two or three of halogen;

R_{120} is heteroaryl, which is optionally substituted with 1 or 2 R_{125} groups; and

15 R_{130} is heterocyclyl optionally substituted with 1 or 2 R_{125} groups;

20 R_2 is selected from the group consisting of H; C₁-C₆ alkyl, optionally substituted with 1, 2, or 3 substituents that are independently selected from the group consisting of C₁-C₃ alkyl, halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, and -NR_{1-a}R_{1-b}; wherein

25 R_{1-a} and R_{1-b} are -H or C₁-C₆ alkyl;
- (CH₂)₀₋₄-aryl; - (CH₂)₀₋₄-heteroaryl; C₂-C₆ alkenyl; C₂-C₆ alkynyl; -CONR_{N-2}R_{N-3}; -SO₂NR_{N-2}R_{N-3}; -CO₂H; and -CO₂-(C₁-C₄ alkyl);

30 R_3 is selected from the group consisting of H; C₁-C₆ alkyl, optionally substituted with 1, 2, or 3 substituents independently selected from the group consisting of C₁-C₃ alkyl, halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, and -NR_{1-a}R_{1-b}; - (CH₂)₀₋₄-aryl; - (CH₂)₀₋₄-heteroaryl; C₂-C₆ alkenyl; C₂-C₆ alkynyl; -CO-NR_{N-2}R_{N-3}; -SO₂-NR_{N-2}R_{N-3}; -CO₂H; and -CO-O-(C₁-C₄ alkyl);

35 wherein

40 R_{N-2} and R_{N-3} at each occurrence are independently selected from the group consisting of

-C₁-C₈ alkyl optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of -OH, -NH₂, phenyl and halogen; -C₃-C₈ cycloalkyl; -(C₁-C₂ alkyl)-(C₃-C₈ cycloalkyl); -(C₁-C₆ alkyl)-O-(C₁-C₃ alkyl); -C₂-C₆ alkenyl; -C₂-C₆ alkynyl; -C₁-C₆ alkyl chain with one double bond and one triple bond; aryl; heteroaryl; heterocycloalkyl; or

R_{N-2}, R_{N-3} and the nitrogen to which they are attached form a 5, 6, or 7 membered heterocycloalkyl or heteroaryl group, wherein said heterocycloalkyl or heteroaryl group is optionally fused to a benzene, pyridine, or pyrimidine ring, and said groups are unsubstituted or substituted with 1, 2, 3, 4, or 5 groups that at each occurrence are independently C₁-C₆ alkyl, C₁-C₆ alkoxy, halogen, halo C₁-C₆ alkyl, halo C₁-C₆ alkoxy, -CN, -NO₂, -NH₂, NH(C₁-C₆ alkyl), N(C₁-C₆ alkyl)(C₁-C₆ alkyl), -OH, -C(O)NH₂, -C(O)NH(C₁-C₆ alkyl), -C(O)N(C₁-C₆ alkyl)(C₁-C₆ alkyl), C₁-C₆ alkoxy C₁-C₆ alkyl, C₁-C₆ thioalkoxy, and C₁-C₆ thioalkoxy C₁-C₆ alkyl;

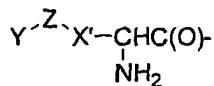
or wherein,

R₂, R₃ and the carbon to which they are attached form a carbocycle of three thru seven carbon atoms, wherein one carbon atom is optionally replaced by a group selected from -O-, -S-, -SO₂-, or -NR_{N-2}-.

2. A compound according to claim 1, wherein R_n is -C(=O)-(CRR')₁₋₆R₁₀₀.

3. A compound according to claim 1, wherein R_n is -C(=O)-(CRR')₀₋₆R₁₀₀, where R₁₀₀ is not -heterocycl-W-aryl.

4. A compound according to claim 1, wherein Rn is



wherein

5 X' is C₁-C₄ alkylidenyl optionally substituted with 1, 2, or 3 methyl groups; or -NR₄₋₆-, where R₄₋₆ is-H or C₁-C₆ alkyl; or

R₄ and R₄₋₆ combine to form -(CH₂)_{n10}-, wherein n₁₀ is 1, 2, 3, or 4;

10 Z is selected from a bond; SO₂; SO; S; and C(O);

Y is selected from H; C₁-C₄ haloalkyl; C₅-C₆ heterocycloalkyl containing at least one N, O, or S; phenyl; OH; -N(Y₁)(Y₂); C₁-C₁₀ alkyl optionally substituted with 1 thru 3 substituents which can be the same or different and are 15 selected from halogen, hydroxy, alkoxy, thioalkoxy, and haloalkoxy; C₃-C₈ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from C₁-C₃ alkyl, and halogen; alkoxy; phenyl optionally substituted with halogen, C₁-C₄ alkyl, C₁-C₄ alkoxy, CN or NO₂; phenyl C₁-C₄ alkyl 20 optionally substituted with halogen, C₁-C₄ alkyl, C₁-C₄ alkoxy, CN or NO₂; wherein

Y₁ and Y₂ are the same or different and are H; C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 substituents selected from the group consisting of halogen, C₁-C₄ alkoxy, C₃-C₈ cycloalkyl, and OH; C₂-C₆ alkenyl; C₂-C₆ alkanoyl; phenyl; -SO₂-C₁-C₄ alkyl; phenyl C₁-C₄ alkyl; and C₃-C₈ cycloalkyl C₁-C₄ alkyl; or

30 -N(Y₁)(Y₂) forms a ring selected from piperazinyl, piperidinyl, morpholinyl, and pyrrolidinyl, wherein each ring is optionally substituted with 1, 2, 3, or 4 groups that are independently C₁-C₆ alkyl, C₁-C₆ alkoxy, C₁-C₆ alkoxy C₁-C₆ alkyl, or halogen.

5. A compound according to claim 1 wherein R_1 is $(CH_2)_{n1-}(R_{1-aryl})$ where n_1 is zero or one and R_{1-aryl} is phenyl optionally substituted with 1, 2, 3, or 4 groups independently selected from C_1-C_6 alkyl optionally substituted with 1, 2, or 3 substituents selected from the group consisting of C_1-C_3 alkyl, halogen, -OH, -SH, -NR_{1-a}R_{1-b}, -C≡N, -CF₃, and C_1-C_3 alkoxy; halogen; C_1-C_6 alkoxy; -NR_{N-2}R_{N-3}; and OH; wherein
10 R_{1-a} and R_{1-b} are -H or C_1-C_6 alkyl;
 R_{N-2} and R_{N-3} at each occurrence are independently selected from the group consisting of - C_1-C_8 alkyl optionally substituted with 1, 2, or 3 groups independently selected from the group consisting of -OH, -NH₂, phenyl and halogen; - C_3-C_8 cycloalkyl; -(C_1-C_2 alkyl)-(C_3-C_8 cycloalkyl); -(C_1-C_6 alkyl)-O-(C_1-C_3 alkyl); -
15 C_2-C_6 alkenyl; - C_2-C_6 alkynyl; - C_1-C_6 alkyl chain with one double bond and one triple bond; aryl; heteroaryl; heterocycloalkyl; or
20 R_{N-2} , R_{N-3} and the nitrogen to which they are attached form a 5, 6, or 7 membered heterocycloalkyl or heteroaryl group, wherein said heterocycloalkyl or heteroaryl group is optionally fused to a benzene, pyridine, or pyrimidine ring, and said groups are unsubstituted or substituted with 1, 2, 3, 4, or 5 groups that at each occurrence
25 are independently C_1-C_6 alkyl, C_1-C_6 alkoxy, halogen, halo C_1-C_6 alkyl, halo C_1-C_6 alkoxy, -CN, -NO₂, -NH₂, NH(C_1-C_6 alkyl), N(C_1-C_6 alkyl)(C_1-C_6 alkyl), -OH, -C(O)NH₂, -C(O)NH(C_1-C_6 alkyl), -C(O)N(C_1-C_6 alkyl)(C_1-C_6 alkyl), C_1-C_6
30 alkoxy C_1-C_6 alkyl, C_1-C_6 thioalkoxy, and C_1-C_6 thioalkoxy C_1-C_6 alkyl.

6. A compound according to claim 5, wherein R_1 is aryl, heteroaryl, heterocyclyl, - C_1-C_6 alkyl-aryl, - C_1-C_6 alkyl-

heteroaryl, or $-C_1-C_6$ alkyl-heterocyclyl, where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, -OH, -SH, -C≡N, -NO₂, -NR₁₀₅R'₁₀₅, -CO₂R, -N(R)COR', or -N(R)SO₂R' (where R₁₀₅, 5 R'₁₀₅, R and R' are as defined above), -C(=O)-(C₁-C₄) alkyl, -SO₂-amino, -SO₂-mono or dialkylamino, -C(=O)-amino, -C(=O)-mono or dialkylamino, -SO₂-(C₁-C₄) alkyl, or 10 C₁-C₆ alkoxy optionally substituted with 1, 2, or 3 groups which are independently selected from halogen, or C₃-C₇ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, -C₁-C₆ alkyl and mono- or dialkylamino, or 15 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, -C₁-C₃ alkoxy, amino, mono- or dialkylamino and -C₁-C₃ alkyl, or C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl each of which is 20 optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, C₁-C₆ alkyl and mono- or dialkylamino; and the heterocyclyl group is optionally further substituted with 25 oxo.

7. A compound according to claim 6, wherein R₁ is -C₁-C₆ alkyl-aryl, -C₁-C₆ alkyl-heteroaryl, or -C₁-C₆ alkyl-heterocyclyl, where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, -OH, -SH, -C≡N, -NO₂, -NR₁₀₅R'₁₀₅, -CO₂R, -N(R)COR', or -N(R)SO₂R' (where R₁₀₅, R'₁₀₅, R and R' are as defined above), 30

-C(=O)-(C₁-C₄) alkyl, -SO₂-amino, -SO₂-mono or dialkylamino, -C(=O)-amino, -C(=O)-mono or dialkylamino, -SO₂-(C₁-C₄) alkyl, or C₁-C₆ alkoxy optionally substituted with 1, 2, or 3 groups which are independently selected from halogen, or

5 C₃-C₇ cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, -C₁-C₆ alkyl and mono- or dialkylamino, or

10 C₁-C₁₀ alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, -C₁-C₃ alkoxy, amino, mono- or dialkylamino and -C₁-C₃ alkyl, or

15 C₂-C₁₀ alkenyl or C₂-C₁₀ alkynyl each of which is optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C₁-C₃ alkoxy, amino, C₁-C₆ alkyl and mono- or dialkylamino; and the heterocyclyl

20 group is optionally further substituted with oxo.

8. A compound according to claim 7, wherein R₁ is -(CH₂)-aryl, -(CH₂)-heteroaryl, or -(CH₂)-heterocyclyl, where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, -OH, -SH, -C≡N, -NO₂, -NR₁₀₅R'₁₀₅, -CO₂R, -N(R)COR', or -N(R)SO₂R' (where R₁₀₅, R and R' are as defined above), -C(=O)-(C₁-C₄) alkyl, -SO₂-amino, -SO₂-mono or dialkylamino, -C(=O)-amino, -C(=O)-mono or dialkylamino, -SO₂-(C₁-C₄) alkyl, or

C_1 - C_6 alkoxy optionally substituted with 1, 2, or 3 groups which are independently selected from halogen, or

5 C_3 - C_7 cycloalkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C_1 - C_3 alkoxy, amino, - C_1 - C_6 alkyl and mono- or dialkylamino, or

10 C_1 - C_{10} alkyl optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, - C_1 - C_3 alkoxy, amino, mono- or dialkylamino and - C_1 - C_3 alkyl, or

15 C_2 - C_{10} alkenyl or C_2 - C_{10} alkynyl each of which is optionally substituted with 1, 2, or 3 groups independently selected from halogen, -OH, -SH, -C≡N, -CF₃, C_1 - C_3 alkoxy, amino, C_1 - C_6 alkyl and mono- or dialkylamino; and the heterocyclyl group is optionally further substituted with oxo.

20 9. A compound according to claim 8, wherein R_1 is -CH₂-phenyl or -CH₂-pyridinyl where the ring portions of each are optionally substituted with 1, 2, 3, or 4 groups independently selected from halogen, C_1 - C_4 alkoxy, hydroxy, -NO₂, and

25 C_1 - C_4 alkyl optionally substituted with 1, 2, or 3 substituents independently selected from halogen, OH, SH, NH₂, NH(C_1 - C_6 alkyl), N-(C_1 - C_6 alkyl)(C_1 - C_6 alkyl), C≡N, CF₃.

30 10. A compound according to claim 9, wherein R_1 is -CH₂-phenyl or -CH₂-pyridinyl where the phenyl or pyridinyl rings are each optionally substituted with 1 or 2 groups independently selected from halogen, C_1 - C_2 alkyl, C_1 - C_2 alkoxy, hydroxy, -CF₃, and -NO₂.

11. A compound according to claim 10, wherein R₁ is -CH₂-phenyl where the phenyl ring is optionally substituted with 2 groups independently selected from halogen, C₁-C₂ alkyl, C₁-C₂ alkoxy, hydroxy, and -NO₂.

12. A compound according to claim 11, wherein R₁ is is benzyl, or 3,5-difluorobenzyl.

10 13. A compound according to claim 1, wherein X is O.

14. A compound according to claim 1, X is S.

15 15. A compound according to claim 1, X is NR₂₀.

16. A compound according to claim 1, X is NR₂₀NR₂₀.

17. A compound according to claim 1 selected from the group consisting of:

N'-{(1S)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-N,N-dipropylisophthalamide;

N'-{(1S)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-methyl-N,N-dipropylisophthalamide;

N'-{(1S)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-bromo-N,N-dipropylisophthalamide;

N'-{(1S)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-cyano-N,N-dipropylisophthalamide;

N'-{(1S)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-N,N-dipropylisophthalamide;

N'-{(1S)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-

ethylbenzyl)oxy]propyl}-N,N-dipropyl-5-(1,3-thiazol-2-yl)isophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-ethynyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-ethyl-*N,N*-dipropylisophthalamide;

*N*³-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-*N*⁴,*N*⁴-dipropylbenzene-1,3,5-tricarboxamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-[(dimethylamino)methyl]-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethynylbenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethynylbenzyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-(trifluoromethyl)benzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-(trifluoromethyl)benzyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-isopropylbenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-isopropylbenzyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-methoxybenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-

dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-methoxybenzyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-ethynylphenyl)cyclopropyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-ethynylphenyl)cyclopropyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-[3-(trifluoromethyl)phenyl]cyclopropyl)oxy]propyl]-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-[3-(trifluoromethyl)phenyl]cyclopropyl)oxy]propyl]-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-isopropylphenyl)cyclopropyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-isopropylphenyl)cyclopropyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-methoxyphenyl)cyclopropyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-methoxyphenyl)cyclopropyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-ethylphenyl)cyclopropyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(1-(3-ethylphenyl)cyclopropyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N^4 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-(1,3-oxazol-2-yl)- N^2,N^2 -dipropylpyridine-2,4-dicarboxamide;

N^4 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-methyl- N^2,N^2 -dipropylpyridine-2,4-dicarboxamide;

N^2 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-(1,3-oxazol-2-yl)- N^4,N^4 -dipropylpyridine-2,4-dicarboxamide;

N^2 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-6-methyl- N^4,N^4 -dipropylpyridine-2,4-dicarboxamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-*N*-ethyl-5-(1,3-oxazol-2-yl)-*N*-propylisophthalamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-*N*-ethyl-5-methyl-*N*-propylisophthalamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-*N*-butyl-*N*-methyl-5-(1,3-oxazol-2-yl)isophthalamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-*N*-butyl-*N*,5-dimethylisophthalamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(3-ethylbenzyl)oxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(6-ethylpyridin-2-yl)methoxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N^1 -{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(6-

ethylpyridin-2-yl)methoxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(4-ethylpyridin-2-yl)methoxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(4-ethylpyridin-2-yl)methoxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(4-ethylpyrimidin-2-yl)methoxy]propyl}-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-{(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-[(4-ethylpyrimidin-2-yl)methoxy]propyl}-5-methyl-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-3-butoxy-1-(3,5-difluorobenzyl)propyl]-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-3-butoxy-1-(3,5-difluorobenzyl)propyl]-5-methyl-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-(3-methylbutoxy)propyl]-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-(3-methylbutoxy)propyl]-5-methyl-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-propoxypropyl]-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-propoxypropyl]-5-methyl-*N,N*-dipropylisophthalamide;

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-isobutoxypropyl]-5-(1,3-oxazol-2-yl)-*N,N*-dipropylisophthalamide; and

N'-[(1*S*)-2-amino-1-(3,5-difluorobenzyl)-3-isobutoxypropyl]-5-methyl-*N,N*-dipropylisophthalamide.

18. A method of treating a patient who has, or in preventing a patient from getting, a disease or condition
5 selected from the group consisting of Alzheimer's disease, for helping prevent or delay the onset of Alzheimer's disease, for treating patients with mild cognitive impairment (MCI) and preventing or delaying the onset of Alzheimer's disease in those who would progress from MCI to AD, for treating Down's
10 syndrome, for treating humans who have Hereditary Cerebral Hemorrhage with Amyloidosis of the Dutch-Type, for treating cerebral amyloid angiopathy and preventing its potential consequences, i.e. single and recurrent lobar hemorrhages, for treating other degenerative dementias, including dementias of
15 mixed vascular and degenerative origin, dementia associated with Parkinson's disease, dementia associated with progressive supranuclear palsy, dementia associated with cortical basal degeneration, diffuse Lewy body type of Alzheimer's disease and who is in need of such treatment which comprises
20 administration of a therapeutically effective amount of a compound selected from the group consisting of a substituted aminoalcohol of the formula (I), or a pharmaceutically acceptable salt or ester thereof, wherein X, R₂₀, R₁, R₂, R₃, R_n and R_c are as defined in claim 1.

25

19. A method for making a compound according to claim 1.

20. A pharmaceutical composition comprising a compound according to claims 1 in combination with a physiologically acceptable carrier or excipient.
30

21. The use of a compound or salt according to claim 1 for the manufacture of a medicament.

22. The use of a compound or salt according to claim 1
5 for the manufacture of a medicament for use in the treatment or prevention of Alzheimer's disease, mild cognitive impairment Down's syndrome, Hereditary Cerebral Hemorrhage with Amyloidosis of the Dutch-Type, cerebral amyloid angiopathy, other degenerative dementias, dementias of mixed
10 vascular and degenerative origin, dementia associated with Parkinson's disease, dementia associated with progressive supranuclear palsy, dementia associated with cortical basal degeneration, or diffuse Lewy body type of Alzheimer's disease.

INTERNATIONAL SEARCH REPORT

Intern	Application No
PCT/US 03/28388	

A. CLASSIFICATION OF SUBJECT MATTER					
IPC 7	C07C233/78	C07C255/57	C07D263/32	C07D277/30	C07C237/34
	C07D413/04	C07D213/81	C07D413/12	C07D213/30	C07D239/26
	A61K31/166	A61K31/277	A61K31/421	A61K31/426	A61K31/4439

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07C C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, BEILSTEIN Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02 02505 A (ELAN PHARM INC) 10 January 2002 (2002-01-10) claims; examples 6-9 -----	1-22
X	WO 02 02512 A (UPJOHN CO ;ELAN PHARM INC (US)) 10 January 2002 (2002-01-10) claims; examples -----	1-22
A	WO 94 17096 A (GIRIJAVALLABHAN VIYYOOR M ;PATEL NAGINBHAI M (US); BENNETT FRANK () 4 August 1994 (1994-08-04) example 8-11 claims 1,6 -----	1-22

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

12 January 2004

Date of mailing of the international search report

20/01/2004

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/28388

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61K31/44 A61K31/505 A61K31/506 A61P25/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 03/28388

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
Although claim 18 is directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.
2. Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Internat'l Application No
PCT/US 03/28388

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